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NEW YORK'S COMMERCIAL BLIGHT—I.

By William Nelson Black.

A VERY surprising manifestation of the power of habit and tradition for maintaining abuses is to be observed along the water-front in the city of New York. We find here a situation unprecedented in history, and unparalleled elsewhere on the face of the globe in any community civilized enough to regard property rights. It is a situation that is working most mischievously on the commercial prosperity of the city, and damaging its property interests to an amount beyond all calculation. Yet it is maintained, and it has been maintained now for a period of about two centuries. It seems to be viewed by the men most directly interested with a sort of stupified sense of helplessness and patient endurance that would be painful to contemplate, were it not a little amusing. As a matter of fact it is a situation so idiotic, and at the same time so palpably injurious, that it could be amended in a very brief period by an appeal to public opinion.

During the seventeenth century the English and Dutch contended valiantly for the possession of Manhattan Island, then a part of the Nieu Netherlands. The Dutch settled it, the English took it, the Dutch retook it, and the English finally recovered it again by cession at the conclusion of a treaty of peace between the two belligerent nations. Shortly afterward Thomas Dongan, Lord Thomas, it is to be presumed, was sent over as Governor. He found that while the English held possession of Manhattan Island by a political title the Dutch still held possession of the lands, including the riparian lands, by a proprietary title. Here was a situation to try the resources of a statesman of the period. How to

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get possession of those lands was the question. He had brought over no authority to confiscate ; but in the place of the authority he was seized with a bright idea. In the name of the Crown he would confiscate and deliver over to the Commonalty of New York the title to all the submerged lands of the Dutch riparian landholders between Corlears Hook on the East river and the present foot of Canal street on the North river. To a maritime people like the Dutch the remaining upland would then be so worthless that it could be had for a song. Of course this act was an act of confiscation. From time immemorial the laws of every nation in Christendom have given to the owners of riparian upland a title to the submerged lands adjacent to their holdings, and it was the law of England. But it was confiscation sugar-coated, like many another political outrage, by the pretence of rendering a public service. Happily for Dongan, the idea of revolt was so hopeless while England and Holland were at peace that the Knickerbockers were forced to submit.

The sequel to the transaction has been such that the title of "Dongan's Curse" might very properly be written over the charter, deed of gift, or whatever the original parchment transferring the lands may be called. An act which would have been pronounced unconstitutional even in England, if the England of that period recognized any constitutional limitations on the power of confiscation, has been imitated by the State of New York. In defiance not only of the common law but of the spirit of her own statute law, which explicitly forbids the grant of submerged lands to any one but the owner of the adjacent upland, Dongan's grant has been extended by the State until all the riparian property of New York City has been practically destroyed. All of which serves to show that rascality does not always propagate rascality. It sometimes propagates idiocy. You might as well cut a horse in two with the idea that the two parts will pull the load of two horses as to cut riparian lands in two in the expectation that any benefits will follow.

This may be thought pretty strong language to use in advance of any more comprehensive statement of facts. But it is to be presumed that most readers of illustrated articles have a habit of looking over the pictures before reading ; and the pictures that embellish this article make within themselves a very strong presentation of facts. New York has many buildings of which her citizens are justly proud; but along the water-front her structures are not merely a disgrace to her own civilization : They are a reflection on the

VALUABLE USES OF METROPOLITAN REAL ESTATE—JACKSON AND SOUTH STREETS, EAST RIVER.

civilization of the country, which cannot escape the shadows falling from its metropolitan center. The water-front structures of New York are so shockingly bad indeed, that a high-toned publisher of a Chicago magazine would probably hesitate before admitting this article, with all its embellishments, into his periodical. He would fear the charge of attempting to traduce a rival, or of jealously maligning a superior city. Nothing but a stern sense of duty, in fact, will justify the exposure of the pictures in even a New York publication. It can hardly be claimed, therefore, with justice, that no facts have been produced which will sanction the use of strong language.

But let us have the facts that must be given without embellishment, and then an explanation in greater detail of all the causes that have led up to this very startling body of facts.

It is a fact, in the first place, that, striking out the value of the piers which have been bought by individuals or companies, from the city of New York, and which do not, therefore, represent values springing from riparian rights, five miles of the best water-front

WEST STREET AT THE FOOT OF KING.

WEST STREET AT THE FOOT OF CHARLTON.

property in New York, all improved, is assessed at not very much more than one-half as much as four miles of corresponding property in Brooklyn, only about two-thirds improved. In round numbers, the figures on the blotters are $9,000,000 for New York, and $14,000,000 for Brooklyn. Yet the latter property is notoriously assessed at less than half its value, while the former, judging by the kind of buildings which owners find it profitable to build, and the nature of the traffic to be seen along the water-front, is over-assessed.

It is a further fact that the value of the riparian property in New York between the foot of Corlears Street and the Battery, two miles long, has been steadily declining during the thirty years that Brooklyn has been rapidly rising. Compared with its condition thirty years ago it is now an abandoned district. It does not furnish a remarkably good location for even a gin-mill. Many such mills remain, but the proprietors hardly rank among the gilded saloon-keepers.

It is a further fact that in the export and import trade of the

port the commerce of Brooklyn is rapidly passing the commerce of New York. It has been estimated that as high as 70 per cent. in value of the merchandise in transit never touches the New York shores. The great ocean liners alone, which continue landing in New York for the convenience of their passenger traffic, save the city from a total eclipse.

It is a further and final fact that westward and southward the march of commerce is taking its way from New York to the shores of New Jersey and Staten Island, and that all indications point to the conclusion that the city will soon have little left to show for its ancient commercial greatness—except its DEPARTMENT OF DOCKS!

Go along the widened section of West street, the improved section the dock department calls it, and follow the trail from Canal street northward as far as you have patience to go. This advice is not given to readers at a distance. It is given to New Yorkers, to men long resident in the city who remain in the interior and fancy themselves citizens of an altogether magnificent metropolis. Away over yonder, as you reach the interior boundaries of the exterior streets, you will discover a long, low line of shedded piers, looking as though they had floated half way out to sea; and between them are the prows of ocean-going steamers appearing for all the world as if they had tried to reach the warehouses of New York but had stranded near the entrance to the harbor. On the outer borders of the beach, which the dock department calls the improved section of West street, the cargoes of these steamers lie where they were jetisoned, protected by tarpaulins or blankets. But do not waste time observing the piers, the steamships, or the cargoes. They are still at sea, and hold only very distant relations with the city. Let the proud New Yorker from the interior run his eye along the line of buildings opposite the piers. If he does not return to his Murray Hill associations with a very crest-fallen feeling, it will be because he has been along the water front before and knows that a pigsty may be thought admirable because it meets all the requirements of the pig.

The buildings visible are mostly one- or two-story shells, sometimes not very far surpassing in material or finish those up-town cabins that were formerly perched on the rocks or in the ravines west of Central Park and occupied by squatters. An occasional three-story building along the line looks almost palatial in its proportions, and the traffic to be observed is of the cheapest kind.

OUR COMMERCIAL GREATNESS AS IT GREETS THE FOREIGNER —OPPOSITE THE PIER OF THE GREAT CUNARDERS.

Something of the aspect of the neighborhood may be gathered from the illustrations; but all pictures flatter. Filth becomes picturesque when it is made pictorial, and it cannot be reproduced, on an uncolored surface at least, in its true likeness. At one point, just north of Christopher street nearly opposite the piers of the most magnificent ocean steamships in the world, stands a solid block of gin-mills of the lowest class, solid except for the one filthy shop devoted to the sale of cast-off clothing sandwiched into the row. Yet some of the property in this district belongs to the Astor estate, an estate that builds sumptuous hotels and superior office and financial buildings in sections where they can be made profitable. Much of the property, indeed, is held by hands that would speedily improve it were any inducements to be found.

This should be a very significant exhibit of facts to follow and accompany the exhibit of New York-made pictures. And now let us find the engineering blunders that have led to these peculiar facts. It would be hard to say who first conceived the idea of that exclusively New York embellishment, an exterior street. If he was a civil engineer he should have been hanged, together with his plans, to the nearest lamp-post. But it is not probable that he was a civil engineer; and he was certainly neither a warehouseman nor merchant, for, had he been either one of these two, he would have known the value of economy in handling merchandise. It may be pronounced definitely certain that he was a truckman, possibly a truckman elected to the Common Council. For a truckman, the idea of an exterior street would have been a very brilliant conception, precisely the thing needed for the promotion of his industry; and under the system inaugurated by Dongan he could find the best possible chance for the exercise of his talents. Had the riparian-propertyholders owned the submerged lands they would have protested vigorously against exclusion from their piers. They would have seen that they needed the land for warehouses, and the execution of the plan would have been made impossible; but not owning the piers they thought possibly that an exterior street might bring traffic to their neighborhood. In any case, they were already ruined and had little more to lose.

The conception of the truckman has been very fruitful in results. On account of those streets, covering the entire district where traffic once concentrated, the commerce of New York is more expensively conducted than the commerce of any other con-

A FASHIONABLE WEST-STREET RESTAURANT— RENTED FROM THE MUNICIPALITY OF NEW YORK.

siderable commercial city on the globe. No storage or wholesale warehouses are found along the water-front, where all such warehouses should be located. For storage-room for heavy merchandise, shippers must seek the Brooklyn warehouses; and as the wholesale traffic of New York can only be conducted by the aid of trucks, merchants have thought the higher ground of the interior more eligible for the location of warehouses than the water-front. It has come to pass, therefore, that during traffic-hours a continual procession of trucks is seen either moving along and blockading the streets against all other vehicles or standing hours in line awaiting the chance to receive or discharge lading.

OPPOSITE THE PIER OF THE INMAN LINE STEAMERS.

[Prosperity that has induced the adoption of the American flag.]

There are about 35,000 trucks in New York, very largely if not mainly engaged in a perfectly useless service, or in a service that could be withdrawn from the streets and rendered for half the current costs. Estimating on the cost of maintaining and running a truck, $50,000,000 a year would not be an unfair statement of the tax imposed on commerce by these exterior streets, and one half could be saved. The superfluous trucks of New York would make a continuous procession from the city to Chicago. Yet the corporations are charged with destroying pavements. The designer of an exterior street must have been the Napoleon of truckmen. His descendent fellows should place a monument to his memory in some crowded thoroughfare on a pedestal of dry-goods boxes.

Now, observe in the sequel to the opening of these exterior streets, how a traditional abuse may not only perpetuate itself, but, when linked with a little cupidity and political thimble-rigging combined, corrupt and demoralize even the civil engineer. Under the operations of our democratic theory of restricted government, the city of New York was for many years gradually outgrowing the effect of Dongan's astute maneuver. If the riparian landholders of the city could not receive a grant of the submerged lands adjacent to their uplands on application, they could at least buy them from the city on the best terms obtainable; and, though the exterior streets had greatly impaired their utility, many took advantage of their opportunities. The city in short was selling the stolen property, private citizens were buying, and the whole nefarious transaction might have been closed out at last, when the brilliant but supremely undemocratic idea of a municipal dock department was conceived. This opened the way for the crowning disaster. Enter the idiotic municipal engineer where only the astute truckman had reigned. The narrow exterior streets, no more than fifty feet wide, conceived by the truckman, were expanded into broad plazas two hundred and fifty feet wide by his successor; and all the resources of New York were pledged to banishment of her commerce.

There is no other industry in New York that has half so many representatives as the truck service. The spectacle to be witnessed daily on the streets, the direct fruit of stupid water-front arrangements, is enough to put any man with an engineering instinct in a delirium of conflicting emotions. When dodging around under truck poles, or trying to make breaches in blockades, he hardly knows whether to laugh at the supreme absurdity of the situation, or to commit the sin that was so easily washed into oblivion by the tear-drop of the recording angel in the less pardonable case of my Uncle Toby. Yet this situation has been maintained for generations simply because it had a political origin, and was woven into the political machine. Men seem to think that it would be like attempting to break up the foundations of the universe were they to move for an amendment.

The writer confesses that he is a political iconoclast. There is nothing that he attacks so cheerfully as a political abuse. He finds in the assault the combined enjoyment of a clergyman rebuking sin, of the doctor wrestling with disease, and of the sheriff pursuing a bankrupt. What if the abuse is not always eradicated immediately? It is exposed; and sensible men may finally be made to

see that they are shivering at a bogie. He differs, however with most political reformers. He never recommends the hair of the dog to cure the bite.

After the experience of the last thirty years, one fact in relation to the New York water-front should be clear. It cannot be maintained at its present status without finishing the career of the city as a commercial entrepôt. There are other superstitions that afflict us besides the political superstitions on which the dock department rests; and one of the most groundless is founded on the idea that New York, a city created exclusively by her commerce, is necessarily the leading city of the continent. As a matter of fact her lead is threatened at her very doors. Fifty years ago Brooklyn was a mere village of about the rank of Astoria, and New York was rapidly approaching if she had not already passed her first three hundred thousand inhabitants. Even thirty years ago the relative position of the two cities had not greatly changed. Brooklyn had grown considerably, but so had New York; and no one looked across the East River with the expectation of ever discovering anything more than a suburb. About thirty or little more than thirty years ago, however, practical men began to see the utter hopelessness of the New York water-front system for the service of commerce and then Brooklyn took her first steps in a race for the leading metropolitan position. Ten years ago her population had risen to something less than one-half that of New York. At the present time it is approaching two hundred thousand more than half; and by the end of the current decade she will range well alongside of her maritime rival numerically, and far surpass her in the magnitude of her shipping operations. Annexation! It would be more sensible to talk of annexing New York to Brooklyn for the purpose of having some of the dock rats exterminated.

"Well, but it is all in the family," some sentimental citizen of New York will exclaim. Yes, it is all in the family; but that does not prove that there is not a fool in the family. Is it sensible for New York to see her riparian property declining continually in value and practically destroyed, her shipping floating from her shores, her growth retarded and her standing impaired in order that she may nurse a political superstition?

New York has long been a great wholesale city. Many of her leading wholesale houses were founded before Brooklyn was commercially born, and it is not to be expected that a city that has practically sprung into being within the last two or three decades

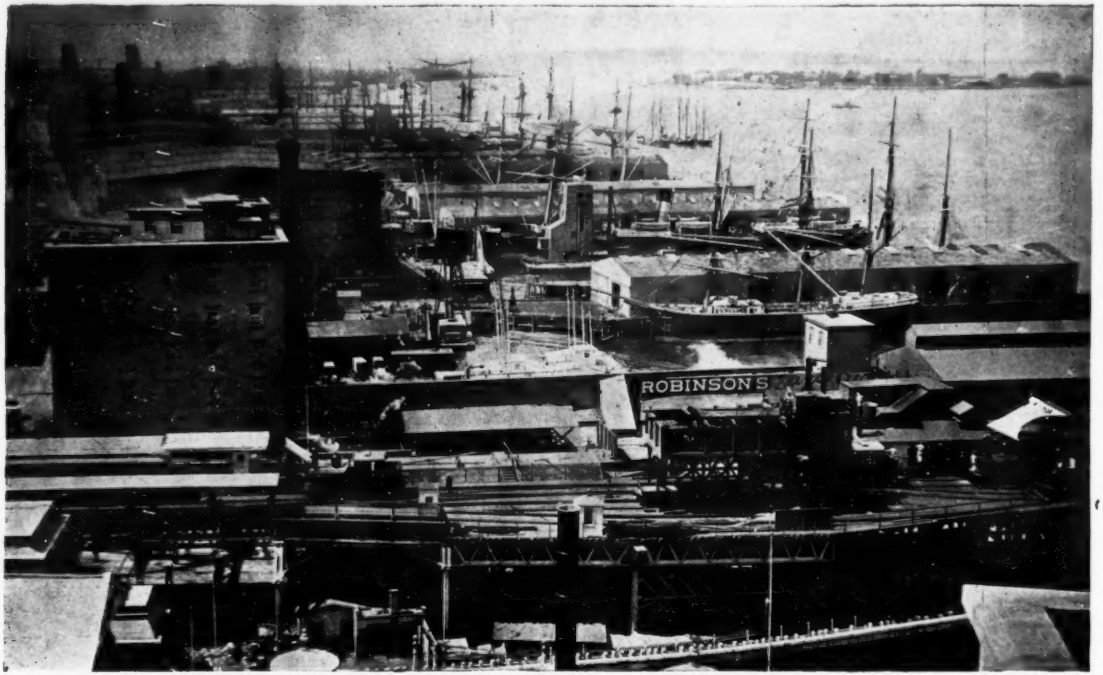
TRUCKS OFF DUTY—SOUTH, NEAR CORLEARS STREET, EAST RIVER.

could immediately displace merchants who have their customers in every part of the Union. As yet, it cannot be said that Brooklyn has even engaged in the wholesale traffic. In some specialties her retail traffic is beginning to rival that of New York, and to even draw customers across the river ; but except among her large manufacturing concerns she has not yet thought it expedient to move against the wholesale traffic of her commercial competitor. She has been content to capture the outposts and abide by the certainty that the citadel can be won whenever the conditions are fully prepared. She is having greatness thrust upon her and can wait.

This is one reason why the hegira of the ships across the East river does not seem to have checked the commercial expansion of New York. But there is another reason for the growth of the wholesale district which is less evident. Despite her water-front system, New York has become a great manufacturing city ; and her manufactures combined with the little of foreign merchandise that she can succeed in arresting at the piers, and the further supply that she carts over from Brooklyn, naturally enlarge the boundaries of her traffic districts. But the declining sections of her water-front, as well as the testimony to be taken at the Custom House, prove conclusively that it is mainly her own manufactures that she is now carting about the street, and not the foreign products that she once prided herself upon handling.

Even in her manufacturing industries, however, New York is suffering from her transcendently stupid water-front arrangements. Go over to Brooklyn and observe the arrangements of a people who are permitted to use their right hands as well as their left. Brooklyn is also becoming a great manufacturing city ; but only the light industries that do not draw heavily on the resources of transportation are pushed to any considerable distance from the water-front. Follow the shore of Newtown creek, and from thence the shore of the East river southward, and you find yourself passing through all the dense manufacturing districts of the city as well as through her shipping districts. No large manufacturer in Brooklyn thinks of invading a district that should be thought eligible only for the location of dwellings or retail warehouses.

Nothing could be more unnatural than the situation along the New York water-front, and nothing more mischievous. A chronic pestilence maintaining itself by contagion year after year along the first two or three blocks from the rivers all around Manhattan Island might have an effect about equally deleterious, but it could



SECTION OF BROOKLYN WAREHOUSE DISTRICT AS SEEN FROM THE BRIDGE.

[Showing the relationship of warehouses to docks under natural and constitutional property rights.]

not be worse. Even the factories in New York rather shun than seek the neighborhood of the water-front. The field for a profitable investment is not to be found there, and everything that is not too bulky to move pushes for the interior. The piers, which should be one of the chief sources of profit, are kept non-productive, and land that ought to be worth $50,000,000 to-morrow if placed upon the market is wasted in those idiotic exterior streets.

Yet New York has some advantages, and were her affairs more intelligently conducted she could maintain herself impregnably in a leading position. Her location is central, and the fact that she had pre-empted the wholesale traffic of the port before her rival had entered the field has added immeasurably to her chances. There is also an advantage, everything else being equal, in her physical conformation, the insular lines of Manhattan Island permitting the concentration of a great extent of water-front in a small space. But the events of the past thirty years have demonstrated that all this is more than neutralized by her failure in observing the dictates of both the common law and common sense. She has been attempting to maintain her municipal institutions on a foundation of public plunder, and the attempt is proving to be a most signal failure.

The question that most critically concerns New York to-day does not refer to rapid-transit nor to municipal expansion. It will hardly be sensible to build new lines for the transportation of passengers up-town when there is an imminent probability that the chief movement of population for the next two decades will be southeastward and southward into sections where commerce is permitted to move with free limbs.

[*TO BE CONTINUED.*]

THE FUTURE "WORLD'S HIGHWAY."

III. THE EAST AND WEST WATERWAY.

By T. Graham Gribble, C. E.

IT is said that in the early days of the Civil War, when the Southern successes were making the Federal leaders anxious and apprehensive, Lincoln and some of his Cabinet ministers were in Buffalo, and he, pointing to the elevators and the shipping, said: "Gentlemen, the side which controls this trade need not doubt as to the end of the struggle." If they could behold it now it would seem to them as if they had but recognized the value of an acorn from which the present majestic oak has sprung.

But still it is young, root-bound, straining in all directions for an outlet in the pent-up vigor of its youth; partly in control of railway corporations who use it as a servant; ignorant and uncertain of its destiny. Not alone the traveller from the old country, but the well-informed New Englander, who pays a visit to Buffalo, Detroit or Chicago, is filled both with amazement at the present magnitude of the trade and speculations as to what it will become.

The steamers of the New York Central and Hudson River Railroad Company, are such as the average Englishman imagines on the Atlantic or Pacific, but his idea of a lake steamer is one of those triple deck rocking-beam side-wheelers which ply up the Hudson, or else he very likely fancies that the trade of the lakes is handled by small sailing schooners. *The tonnage passing through Detroit last year exceeded by ten milllon tons, the tonnage of the two ports of Liverpool and London.*

Some years ago the question of a swing-bridge for the straits of Detroit was debated in Congress, and one of the Senators asked whether the bridge would have to be opened more than four times a year. The opponents of the bill worked out the problem and found it would have to be opened *every three minutes.* It need hardly be added that the bill sank to rise no more.

The lovely summer resorts of the Saint Clair river are subject to one serious drawback. The growth in the carrying-trade has been so sudden that the captains have not realized that liberties may be permitted to half a dozen which are absolutely intolerable

with half a thousand. Every great steamer as it passes a place where the captain or mate has some female acquaintance, blows his fearful fog-horn, and as there is a continual procession of steamers and sailors are always popular with ladies, it makes valetudinarians tremble, and all men execrate.

General O. M. Poe, in his report to the Secretary of War upon a ship-channel between the Great Lakes, under date of December 4, 1890, this summarizes his views of the present position of the commerce :

"During the season of 1890 over 9,000,000 tons of freight passed through St. Mary's river and more than 22,000,000 tons through the waterway between Lakes Huron and Erie. The increase in the available depth of channels on the lakes from nine and a half feet in 1852 to sixteen feet in 1882, developed this commerce, and it is only reasonable to expect that a further increase of four feet will be followed by corresponding increase in the shipping. The results are most notable perhaps in the character of the vessels employed in the carrying-trade. These have increased in size and seaworthiness until they form a fleet which has not its equal upon any inland waters on the face of the globe. Of large capacity and great power, regardless of wind or weather, the steamers of the prevailing type bear their cargoes to and from ports a thousand miles apart, with the regularity and precision of railroad trains. each of them transporting at once more than ten ordinary freight trains. Surely such a commerce deserves every aid and encouragement that can be extended to it. Give it channels practically navigable upon a draft of 20 feet and it needs no prophet to predict a wonderful growth, but only a prophet could foretell its degree. For nearly thirty-five years I have watched its increase, but neither I nor any one else within my knowledge has been able to expand at the same rate. The wildest expectations of one year seem absurdly tame the next."

Not only do Americans enthuse when they get upon this subject but, turning their eyes toward Canada, they "rile" over the comparatively greater activity displayed by the Dominion in developing her waterway. Mr. William Pierson Judson, in his report of 1890 upon the proposed Niagara Canal, draws attention to the fact that the Canadian Government, with its small population and limited resources, has recently expended some $54,000,000 in constructing and enlarging its canal system with a view to controlling the western trade.

A study of the map of the Continent will reveal the vast importance of the waterway to Canada. In the adjustment of the frontier the United States have displayed great business acumen, but, contrary to their usual custom, have failed to "get there." Pushing up their territory to the banks of the Saint Lawrence from Oswego to Ogdensburg, they have had to retire to a respectful distance from Montreal, then pushing upward again between North-

ern Quebec and New Brunswick they have wedged in the State of Maine between those provinces and hold the best outlets by rail from Canada to the Atlantic during the winter months. This is a sore point between the Dominion and the mother country; a diplomatic blunder, as they put it, due to astute Washington men who walked round a thick-headed English aristocrat. If they had kept Maine and Portland the Dominion itself would have been in a larger way of business and the Canadian Pacific Railway a bigger boy than he is.

But when we turn from the railway to the waterway we see that Canada has retained the key of the carrying-trade of the great lakes to the ocean not only from her own but also from American shores. From Duluth as much as from Port Arthur, from Chicago as much as from Toronto, the way to the Atlantic for wheat and minerals is by the Saint Lawrence. It will form a great bee-line for the commerce of two hemispheres which by reason of its few obstructions and detentions, its freedom from the necessity of breaking bulk, and its minimum cost of transportation is destined to control a business which no imagination of man is able to picture or estimate. The present canal system competes with the railway in inverse proportion to the lockage. Delays and lockage-dues are the secret of railway pre-eminence over canal transportation to-day, as are strikingly exemplified in the case of the Welland and Erie canals. In addition to this the lockage acts figuratively upon the canal development for it is a "dead-lockage" to the normal development of the draught of vessels. The Welland canal has a most interesting history of struggles with the ever-increasing growth of shipping. The first attempt to give Niagara the go-by was begun when Upper Canada hardly contained 100,000 people and exhibits not only the energy of the Canadians but their keen appreciation of the value of their waterway. To the Honorable W. H. Merritt belong alike the honor and merit of having as early as 1817 not only advocated but promoted the first Welland canal. There are now practically two canals built through about the toughest twenty-five mile cut ever tackled by the engineer. The second canal was not put where it is because it was a better or even as good a location as the first, but because the difficulties of altering the locks on the first were insurmountable. These early canal troubles have arisen from the yearly outgrowth of its clothes by the juvenile industry. Shipbuilding has now reached maturity and canals can be "cut to size" without fear of being left behind like

the Welland canal. Moreover the canals have hitherto had to handle, comparatively speaking, local traffic. The expense and delay of lockage is thus a large factor, but the future of the waterway is to handle transportation over immense distances, in which the above factor will be reduced to a minimum. The tonnage through the Saint Mary's Falls canal now exceeds that of the Suez canal, but none of it goes to the Atlantic by water. It does not require much stretch of imagination to picture six canals between Superior and Huron, as large or larger than the present one, as necessary gateways of a through waterway; commensurate facilities being provided all the way down to the sea.

To all this El Dorado of commerce Canada not only holds the natural outlet in the mouth of the Saint Lawrence, but she has almost a straight two-thousand mile run, and in the total distance only seventy-two miles of physical obstruction through which to maintain engineering works. In contrast with this, a vessel going from Duluth to New York over American water would have three hundred and fifty-two miles of constant detentions via the Erie canal. To place this canal abreast of modern requirements would require an outlay of about $250,000,000, and unless the strategic advantages of the route should warrant large federal appropriations, it does not seem likely that capital would be embarked in so expensive an undertaking.

The Canadian programme commences with a lock at Saint Mary's Falls with a depth of eighteen feet. On the American side the lock is eight hundred feet long, one hundred feet wide and having twenty-one feet depth over the miter sills. Canada has learned enough on the Welland canal to have known better than to build three feet higher than America. She will probably regret those thirty-six inches of cautious cheese-paring—more than a million dollars for each inch. In these two parallel canals the gates are opened to ocean going steamers from all the ports of Lake Superior. The next step in the Canadian path is to join Georgian Bay with Lake Ontario by a ship-railway or ship-canal with outlet at Toronto. The former is estimated by Mr. Corthell to cost $15,500,000, the latter by Colonel R. B. Masson to $22,000,000. Without going closely into the relative merits of ship-railways and ship-canals for which space does not permit, it may be said that engineering opinion leans decidedly towards the ship-railway from its comparative cheapness. This is remarkable because as yet there are no ship-railways. The consensus of opinion

is formed upon the basis of Captain Eads's brains and the fact that a ship-railway is being made at Chignecto. We have plenty of hydraulic ship-docks on which ships of large size generally have to unload before being taken up, to avoid strain to bottom plates when no longer water-borne. Captain Eads, however, convinced all the leading engineers as to the feasibility of the Tehuantepec ship-railway and would doubtless have carried his project through if he had lived. His devices for equalizing strain and easy transit were all on paper or on models, but they carried complete conviction. English engineers were not only convinced but paid the highest tribute to his memory by commencing to build the Chignecto ship-railway for the largest vessels. It must be borne in mind that this new departure comes out like Minerva, full-harnessed from the brain of Jove. We have no early stages of experience in it such as small ship-railways through the greater river portages from which to get our lessons. Not only the difficulties of construction but the cost of operation and maintenance have scarcely materialized. The engineer has conceived and has almost brought to the birth, but the offspring is already crowned by engineering opinion as the king of communications for the inland seas.

It will be noticed that by either canal or ship-track Canada has here the most direct route from Duluth to the sea. Avoiding the down drop of Lake Michigan, passing by the bends of Huron, cutting out Lake Erie and Niagara, she gets nearly a bee-line for the Saint Lawrence. She has another string to her bow in the proposed canal by the Mattawa and Ottawa rivers to Montreal but this, besides being much more costly,—entails a longer stretch of lockage and cuts out her own trade on Lake Ontario and Toronto.

Perhaps the most valuable recent contribution to the literature upon the subject is Mr. Corthell's paper read before the Canadian Society of Engineers and the Western Society of Engineers of Chicago. At the latter reading the discussion was taken up by Messrs. Bates, Day, Marx and Benezette Williams. Mr. Bates makes the remark that the international character of the enterprise furnishes an argument for free-trade and, that if we cannot have free-trade let us have annexation. He suggests that perhaps Canada will be willing to build the ship-railway in exchange for the privilege of being annexed to the United States. Whether or not the United States stands in need of six million more Democratic votes just now, the writer will not presume to say, but it seems about as likely that the canny Canadians would spend their money in the said

canal for the privilege of being annexed as that they should ask Uncle Sam to build it in return for the privilege of being wedded to him. This bee-line over Canadian waters would be the best route from Chicago as well as from Duluth. Even if such a thing as a ship-canal or railway were ever contemplated from Chicago to Toledo there would still be Niagara. but by the Huron-Ontario route all the ports on Michigan would find their shortest and easiest path, avoiding as they would the detour by Detroit.*

On the Canadian programme remain the improvements of the Saint Lawrence Canals of which the following is a summary :

Lachine	8½ miles long and	5 locks.
Beauharnois	11¼ miles long and	9 locks.
Cornwall	11½ miles long and	7 locks.
Farrons Point	0¾ miles long and	1 lock.
Rapide Plat	4 miles long and	2 locks.
Galops	7⅝ miles long and	3 locks.
Total	43⅝ miles long and	27 locks.

The cost for these improvements is estimated by Mr. Corthell, from data furnished by the Canadian Government, at $27,000,000. Mr. Corthell suggests a route from Chicago to Liverpool of first, a ship-canal to Saginaw Bay to avoid the Straits of Mackinaw, thence by way of Georgian Bay to Lake Ontario by the Huron-Ontario ship-railway, the Canadian Government to complete the Saint Lawrence improvements to the required dimensions and then to remove all tolls from the canals. It is not clear to the writer why the Dominion should do this ; the context goes to show that a saving would be effected thereby to American exporters of about $28,000,000 in a year and a development inaugurated which would enhance the prosperity of the 450,000 square miles of American territory comprising the basin of the Great Lakes. It would be a noble act of generosity on the part of Canada, but she is not much given to removing tolls upon canals. It rather goes to show that Canada is not quite an eligible "parte" to the United States.

All said and done, the route by the Saint Lawrence is a summer-month transit and the winter outlet remains in the hands of the United States. The grain crops can all be handled in the summer, but people want coals in winter more than in summer and smelt-

*Mr. H. E. Ketchum, engineer of the Chignecto Ship railway, is credited with a scheme by which vessels of twenty feet draft can be carried through the Saint Lawrence without these improvements. He proposes steel rafts, something like hydraulic docks or pontoons. Ingenious though it may be this would only be a make-shift having regard for the ultimate necessities of the commerce.

ing ores all the year round. The outlook for Canadian commerce is magnificent and she holds a waterway which her greater sister country well may envy, but the States of the Union with their sixty-five millions are in touch with a bunch of inland seas every one of them encircled by the richest lands of the earth. The normal growth of the States will soon create a population capable of absorbing all that the industry of the people can produce, and domestic commerce may be expected to transcend in importance by leaps and bounds that of the foreign trade.

The works of primary importance falling to the lot of the United States are the lakes and gulf waterway described in our last article, the Saint Mary's falls canal just completed, the Saint Clair and Detroit river improvements and the Niagara ship-canal. Other less urgent requirements and of less immediate advantage are a ship-canal from Lake Superior to Lake Michigan west of Sault Sainte Marie; the Michigan-Saginaw ship-railway and the developments of the Erie and Oswego canals from Buffalo to the Hudson. Coming first to the Saint Clair and Detroit river improvements there are two aspects of the problem. One is based upon the consideration of the Saint Clair river as the deep water terminal of the upper lakes, the other regards it only as a channel the outlet of which by the Detroit river into Lake Erie can be made available for deep-draught carriers to Buffalo, Lake Ontario and possibly also to New York via the Hudson. The exponents of the former view argue that the effect of deepening the Detroit river has been hitherto to lower the level of Lake Saint Clair and that the limit of economic deepening and maintenance of the artificial channel will be reached before that of the increasing draught of vessels and that the ultimate end must be a deep water harbor all along the Saint Clair river.

Ex-Senator McElroy, of Saint Clair, who is an encyclopædia of knowledge in all Michigan matters, has written a good deal upon the subject. He terms the obstructions at Bar Point, Limekiln Crossing, Grosse Pointe and the Saint Clair flats, the "reserve dams" of nature, placed there to hold back the waters in the lakes above, the removal of them consequently producing a fall in the lakes necessitating more and more dredging. He contrasts this with Saint Mary's river, where the canal in the upper reaches preserves the headwaters and permits the river below the canal to be dredged to any depth without affecting the level of Lake Superior. Whatever weight there may be in this argument, the comparative cost of a

twenty-foot channel throughout and a twenty-foot channel with twenty-one feet depth in places subject to heavy seas has been estimated by General Poe and stands as follows: For a twenty-foot channel, $2,379,085; for a twenty and twenty-one foot channel, $3,339,567.

Such a vast increase in cost for only a partially increased depth of one foot is suggestive as bearing upon the works of the future supposing that a draught of twenty-five feet or more were to be demanded by the commerce. The figures are also suggestive as to maintenance if the effect of deepening should be what is anticipated by Mr. McElroy upon the level of the lakes.

If the Saint Clair river is to be a deep-water terminal, it will be a noble one, and the cities along its banks will have a splendid future. Imagine the Hudson at New York City only forty miles long; with no high banks, and a current of about two miles an hour. It possesses every facility for jetties, dry-docks and ship-building yards. Already a tunnel is opened at its northern end and others are talked of lower down. Marine City, a town at its southern end of about four thousand inhabitants, has carried on ship building without any railway facilities and is actually building two vessels for the Atlantic trade. It requires no stretch of fancy to picture it a string of sea-ports from which the distribution of the water-borne produce of the upper lakes would be taken up by the railways for the inland States. With regard to the improvements of the Detroit river, these are detailed in a comprehensive manner in the report of General O. M. Poe to the War Department, under date of January 20, 1891. The principal work which has been carried out here has been the Saint Clair Flats ship-canal, the parallel dikes of which are 7221 feet long and 300 feet apart. The dikes were constructed first and then the space between them dredged to a depth of thirteen feet, that is to say one foot more than the depth of the principal lake harbor entrances. In 1873 the requirements of commerce demanded further dredging to a depth of sixteen feet. Quoting from the report:

"The race between the draft of vessels and the available depth of channels did not abate. The shipping interests are, and for some time have been, loudly demanding greater facilities. There are now many vessels on the lakes built for a draft of eighteen feet or more, and they are not loaded accordingly only because the depth of water is insufficient to accommodate them."

It should be remarked that this channel is not self-scouring, like that of the Mississippi jetties at New Orleans. The slack

water of Lake Saint Clair above the channel throws all the maintenance upon the dredger. If this waterway is to be a means of access to the Atlantic it is a question of how far it will ever accommodate a class of vessels which now call for twenty-six and even thirty feet depth over the miter sills in English harbors. The limit to the dredging capacity will be reached when the slope becomes such as to endanger the foundations of the dikes, apart from the question of lowering the level of the lake above. Possibly the whaleback steamer will solve the difficulty, but we await further data upon that new development.

The proposed Niagara ship-canal is the last link in the chain of communication through American waters to the Atlantic. It has been described by Mr. William Pierson Judson, in a pamphlet accompanied by a most useful map and profiles and also by copies of a report of Captain Palfrey, Corps of United States Engineers, and text of the bill introduced by Congressman Payne, December 18, 1889, for a twenty-foot waterway from Lake Erie to Lake Ontario.

At present the shipment from the lakes to New York is unloaded at Buffalo and carried over the seven-foot Erie canal or else by rail. The deep waters of Lake Ontario are unused for this business except by means of the fourteen-foot Canadian Welland canal, which is not a sufficient depth for the larger lake steamers. With the ship-canal completed, vessels would unload at Oswego eight hours after leaving the canal. This point of transshipment is 145 miles nearer to New York than Buffalo and leaves 168 miles less of canal for the barges to traverse before reaching the Hudson. The Niagara ship-canal would have eighteen locks 400x80x21 feet and take about thirty minutes per lock for operation. Two routes are proposed; the longer one of twenty-five miles, known as the Lockport-Olcott route, is preferred by Mr. Judson on the ground of the natural advantages presented by the "Lockport Gulf," two and one-half miles long, in which the descent is made, and also in the eighteen-mile creek-gorge, four miles long, by which Lake Ontario is reached. The cost is estimated at $23,000,000.

The voluminous and very valuable data extant, together with the brief compass of this article, have rendered it more sketchy than the subject merits. In our first article some reference was made to the political aspect of the development of these waterways, showing the possible difficulties arising from conflicting national interests. We will close by endeavoring to point the

moral. The waters which Providence has so generously bestowed upon the race now in possession of the northern half of the New World are not there as a bone for hungry dogs to quarrel over, they are a unifying current to connect them into one; a flux to fuse them. They are there to unite this people not alone with one another but with the homes of their forefathers from which jealousies and blunders have alienated them. This moral has just been forcibly pointed by the rival spirits of war and peace. While the mean little demons of discord have been fretting the cabinets of England and America over the question as to who should reap the chief benefits from the slaughter of the seal to clothe the bodies of the rich, the great angel of peace, touching with one wing the western prairie and with the other the afflicted villages of the Russian steppes has sent forth the freight train and the steamer proudly carrying the free-will offerings of kindly hearts, swiftly spanning the enormous distances which intervened, and so linking in a manner impossible a few years ago, the better natures of the American and Russian people—all hail to Stephenson and Ericsson, to Fulton and Watt!

Free-trade, reciprocity, annexation; all fall short of that best and highest destiny of the race which is already assuming tangible form. Mere British colonial federation, to include Canada and exclude the United States is impracticable now that British commerce with the States is what it is. International federation, not upon the narrow selfish grounds of trust combinations, but upon the broad yet elastic principle of securing to every people the best means of developing its God-given resources with its legitimate reward is the vision which hovers over the Western horizon. When the Saint Lawrence and the Mississippi are delivered from the physical barriers which hinder a world-wide commerce, it may be that the engineer will step aside while a united people shake off their political barriers and establish a common basis of development and a joint court of appeal. The world is about to gather to Chicago, the present focal point of railways and the future focal point of ocean waterways. A more cosmopolitan meeting will never have taken place. May we hope that the World's Fair will be followed by definite steps in the direction of the establishment of a World's Peace Tribunal as the forerunner of International Fiscal Federation?

SANITARY PROGRESS IN NEW YORK.

By Charles F. Wingate.

THE marvellous growth of New York City during the last twenty-five years has almost completely transformed Manhattan Island. The population has more than doubled in this time, as a result of which the greater part of the Island has been covered with houses, while new wards have been annexed from Westchester county to supply more building-sites. The growth of the city has been upwards as well as outward, introducing lofty hotels, office-buildings and apartment-houses. It may be interesting to review the changed sanitary conditions of the metropolis during this period, especially as it happens to equal the age of the Board of Health. Important data upon which to base a comparison may be found in the Report of the Council of Hygiene and Public Health of the Citizens' Association, issued in 1865, mainly the work of the late Dr. Elisha Harris. The startling disclosures made in this report, together with the popular fear of an outbreak of cholera, led to the creation of the Board of Health, which was organized on March 5, 1866, with Dr. Harris as Sanitary Superintendent.

The evils described in this work were the crowded and filthy condition of the tenements, the great number of rear-houses and cellars occupied as habitations, the bad street pavements, the proximity of stables and slaughter-houses to dwellings, the prevalence of sewer-gas—due to bad plumbing in all classes of dwellings—and the absence of food inspection. The new Superintendent set to work with all a reformer's zeal to clean the Augean stable. A sanitary code was drafted and its provisions rigorously enforced. Tenement rookeries were torn down; light-shafts were ordered and transom-windows cut to admit light and air; cellar occupants were evicted; privy-vaults were cleaned and replaced by school-sinks; slaughter-houses were abolished in the down-town sections, or near dwellings, and were concentrated along the river-fronts above Forty-second street; the driving of droves of cattle through the streets was forbidden; stables situated near dwellings were strictly regulated, as well as common lodging-houses, markets, offensive trades, etc. The new broom swept fiercely and accom-

plished wonders, as was seen in the greatly-reduced death-rate, as well as in other practical evidences of improvement. During the ten years preceding 1860 the annual death-rate of New York was 33.66 per 1000, and for the succeeding five years it was 31.33. Since that date it has steadily declined and in 1891 the rate was 24.58. This represents a decrease in twenty-five years of 5.79 per 1000, or a saving of over 80,000 lives for the whole period

In 1873 Professor Charles F. Chandler, the Chemist of the Board and Dean of the Columbia School of Mines, was chosen President of the Board of Health and retained the position for ten years. He carried out many important reforms during his term of office, chief among which was the drafting of a law, in 1880, requiring the plans of the plumbing in all new buildings to be approved by the Health Board, and the work to be subject to inspection. As a result, a vast improvement has been made in the quality of the plumbing, in all buildings ; a higher standard of workmanship has been encouraged ; incompetent and unscrupulous contractors have been weeded out, and a great step in advance has been made. Other large cities have secured similar enactments and incalculable benefits have resulted. Architects, builders, plumbers and the public generally have been educated to appreciate the value of good plumbing. The tenement-house law was also amended in important particulars, limiting the depth of such houses and requiring that a certain space should be reserved at the rear of each lot, increasing the area of light-shafts, and forbidding the erection of rear-tenements except under special conditions.

The increasing pressure of population has made every available inch of space upon Manhattan Island of enormous value. Through the expansion of business and the general march of improvement many crowded sections and "slums" have been swept away and replaced by warehouses and other buildings. The extension of Worth street opened up the celebrated "Five Points." The construction of the Brooklyn Bridge destroyed many notorious rookeries. A famous fever-nest in Leonard street is now part of the dry-goods district and the entire section below the City-Hall is largely cleared of tenements. One of the worst dens on Frankfort street has been converted into an office building. Gotham Court, in Cherry street, has been completely renovated, and the Big Flat on Elizabeth street transformed into a factory.

In 1866 most of the streets were paved with cobblestones, full

of ruts and hollows and imperfectly cleaned. The main thoroughfares have since been repaved chiefly with Belgian blocks and, within a very short time, many miles of granite blocks have been put down in Broadway and other streets. After numerous experiments this has been given the preference in view of the heavy traffic in New York streets. It is about decided that New York is to spend $1,500,000 a year for two years in the repaving of streets —a sum which, in addition to the $3,000,000 lately invested in similar improvements, will make it one of the best-paved cities in the world.

The record of what has been accomplished in the way of sanitary improvement in New York is certainly commendable and encouraging, but much yet remains to be done. The sanitary needs of the city have grown faster than the means to supply them. The rapid and unprecedented massing of population, the growth of the tenement-house system, the multiplication of manufactories and cheap lodging-houses, and above all the influx of a multitude of poor, ignorant and uncleanly emigrants, have all exerted a potent influence upon the public health. The result is seen in a death-rate which is still too high and the steady prevalence of and virulence of zymotic disease.

While many tenements of the most objectionable character have disappeared as stated already, tenements have increased in number in other quarters. Rapid-transit has supplied no relief to the very poor in the congested districts, from their inability to spare either time or money for travel. "To say that the poor should go to the suburbs," in the words of an English statesman, "is to say that they should go to the devil." Hence tenement-houses and cheap apartment-houses, instead of remaining confined to the region below Fourteenth street, have spread on the east and west sides of the city as far up as Harlem, where "Little Italy" is as conspicuous for dirt and disease as the Mulberry-street Bend. These buildings have multiplied until there are now sixteen inmates to the average dwelling and two-thirds of the city's population are housed in tenements.

Not all of the tenements are hot-beds of disease, but a large proportion are in a fairly sanitary condition. Many so-called tenements are really second-class flats and a large number of actual "double-deckers" are fairly good. But a large number are quite the reverse and the system as a whole is bad, encouraging the herding of scores of families under one roof, with no individuality

and little real home-life, and with inevitable temptations to immorality and intemperance. The sanitary influence of the tenements is best revealed by the records of the Registrar of Vital Statistics, which show that the bulk of the cases of zymotic disease and most of the child mortality occurs in such buildings.

If the very bad houses were rigidly supervised by the authorities, their condition might be materially improved. Perhaps one-fifth of all the tenements need radical renovation. Most of the rear-houses should be condemned, and with them perhaps five hundred others which are specially defective. If these were rooted out entirely it is quite certain that better houses would be built near by, sufficient to contain the displaced tenants. There is an abundance of land in the down-town wards now covered with small houses which, if replaced by commodious model dwellings, would accommodate many thousands comfortably.

Nothing has yet been attempted in New York on anything like the scale on which such work has been undertaken abroad, to deal with the slums and to clear away crowded tenements *en masse*, so as to provide breathing-spots in the most thickly-populated districts. It is true the Small-Parks bill passed by the Legislature in 1887 provided for clearing away the notorious Mulberry-street Bend and planting small parks in other sections, but while most of the legal proceedings preliminary to the work have been completed, further action has been delayed, and the Italian Quarter still retains its unenviable record for filth and mortality. It is only a question of time when our people will awake to the necessity of broad sweeping measures for dealing with the tenement slums as a matter of public safety. A number of blocks of model tenements have been erected in New York, notably those in Cherry street and at Seventy-first street and Second avenue, but these have attracted a superior class of tenants and have not proved beneficial to the very poor. Far better results have followed from the efforts of Miss Ellen Collins and others, who have converted old tenements into decent and safe dwellings, with benefit to the tenants and without loss to themselves. Many of the most unhealthy parts of the city are made so by soil dampness due to old water-courses, which have not been drained. If all houses in these sections had water-tight cellars, as the law provides, great benefit would follow. The dampest cellar can be made dry by an asphalt flooring and there is no reason why this provision should not be required in every tenement. It is simply necessary to enforce the law.

It is not alone in relation to tenements that sanitary problems present themselves. The erection of tall office-buildings, hotels and apartment-houses has had a bad effect upon the comfort and health of the residents in neighboring buildings, who are forced to live in constant shadow. The streets lined by these sky-soaring structures seem mere lanes or alleys, damp, sunless and drafty, with piercing winds or whirls of dust, that tax the strongest constitution. Our citizens must soon follow the example of Chicago and restrict the height of all buildings within reasonable limits, both as a sanitary measure and as a precaution against fires. Incidentally it may be noted that the demand for apartment-houses is declining, only 164 plans for such buildings having been filed in 1891 against 290 plans filed in 1890—a decrease of fifty per cent.

The Police lodging-houses in New York have long been a moral disgrace and a menace to health. On a single night 577 homeless wretches were thus cared for and 147,637 lodgings were supplied in a year—all in places little better than pig-sties, and having great facilities for spreading contagion. There is great need of reform in this direction, by copying the system followed in Boston, for instance, where every lodger is decently lodged after a hot bath, and his clothes thoroughly steamed, with the result of reducing the number of tramps to one fourth the former number and of separating them from the respectable poor.

Within recent years a number of new school-buildings have been erected in New York, which are much superior to those previously constructed, especially with respect to light and air. Many of them are corner buildings, which is a great advantage, and one at least is to be fire-proof—a very wise provision, which should be made the rule in all schoolhouses. When a thousand children, liable to panic, occupy one building, no pains should be spared to insure perfect safety. While the plans of the new schoolhouses show a marked advance in sanitary essentials, it has lately been discovered that the workmanship is very faulty. Inferior materials have been substituted. Poor mechanics receiving low pay have been employed in their construction, and the painting, carpentry, plumbing and stone and metal work have all been "scamped" in the most scandalous manner. The matter is now under official investigation. In the meantime the older school buildings have deteriorated very materially. Overcrowding has been the rule, especially in the primary departments. The ventilation is wretched and the plumbing very defective. In some

class rooms gas is burned constantly. In one school only eight out of eighteen class-rooms are really habitable. These facts have recently been made public by Dr. Henry D. Chapin before the Medical Society of New York County and have not been denied. One serious sanitary evil is the custom of allowing janitors to live in school-buildings. Contagious diseases are frequently communicated to the pupils from the children of janitors' families. In one year six outbreaks of diphtheria alone started in this way.

New York has 444¼ miles of sewers, and 685 miles of water-mains. The sewers were built with no comprehensive plan, and often by incompetent and unscrupulous contractors. Many of them have too little fall, and are mere "elongated cesspools;" others are tide-locked, or filled with steam from factory-boilers or other sources. There is no systematic means for ventilation, except by perforated manholes which choke easily with dirt or freeze up. While much has been done of recent years to improve the sewers, there is still great room for further effort in the same direction. A great saving might and should be made in the consumption of water, by the introduction of meters. Millions of gallons are daily wasted, especially in cold weather, through the ignorance or neglect of householders who do not hesitate to let the water run day and night to prevent the fixtures from freezing. Leakage is another prime source of waste, and nothing but compulsory payment by meter will induce the careless public to be less lavish in their use of water.

The removal of garbage without causing a public nuisance is a difficult problem. This is especially the case in the tenement districts, where the amount of kitchen waste is large, and careless tenants are tempted to throw it into the street. Many private families burn their garbage, and cremation is the simplest and most economical plan of getting rid of it on a large scale. This has been successfully tried in many smaller cities and has been repeatedly proposed for the metropolis.

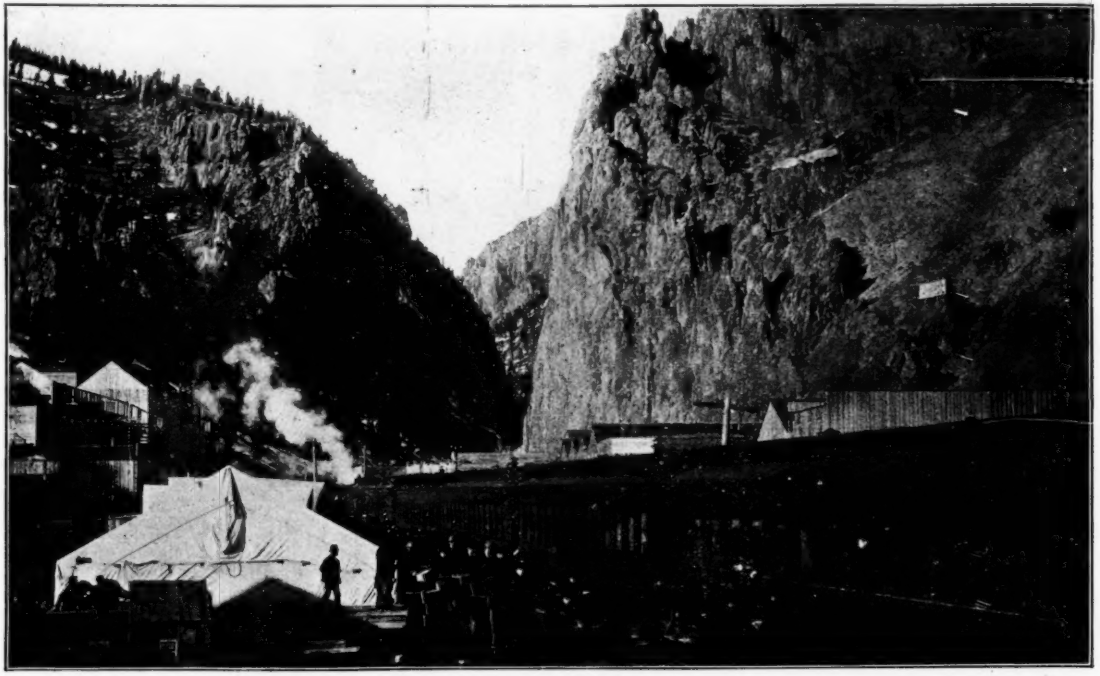
The streets of New York are still far from clean, even if great improvement has been made upon former conditions. There has been too much "politics" in the Street-Cleaning Department, and until it is kept as free from outside influence as the Fire Department the proper performance of its work cannot be hoped for. The air of the metropolis is polluted from many sources. There are too few parks to afford breathing-places in the thickly-populated sections and none to speak of in the tenement districts. There are

almost no trees to purify the atmosphere while lofty buildings shut out the sunlight from the streets and keep them damp and unwholesome. In short, with the exception of the regulations for the construction of new buildings, almost nothing has been done to assail the *causes* of disease, and *preventive* measures have largely been ignored. It is high time that the sanitary future of the metropolis should be considered in a broad and comprehensive manner and the work to be done mapped out on a liberal scale. Despite all that has been done to improve the public health, yet when tried by the highest standards, New York is not a healthy city.

If the work that has been done by the Health Board and other agencies is to be considered as really beneficial then there should be more positive evidence of improvement. All official bodies tend to conservative and slow action. Energy and earnestness are hampered by red-tape and "politics." The official is opposed to startling innovations. He aims to be conciliatory rather than aggressive and naturally moves ahead no faster than public sentiment presses him on. This is excusable, and the blame for delay lies rather with the public, which takes so little interest, than in the official who makes so little effort.

It is difficult to theorize upon sanitary matters in New York, owing to the absence of official data. The Health Board is required by law to make an annual report and to publish the statistics of tenements. But these reports are so brief and the statistics so incomplete that they are of little practical benefit. If we could know just how many houses have had a continuously-bad sanitary record, it would be easy to decide what should be done with them. But such information is no longer made public as formerly, and the Board of Health has become a mere circumlocution office, receiving and grinding out "permits" and "notices," and compiling vital statistics which are utterly unmeaning to most persons.

Does it not seem preposterous to place at the head of the Health Board a layman without the slightest previous knowledge of or interest in sanitary affairs? What is especially needed is the employment of experts in all departments of municipal administration. This, as President Eliot, of Harvard, remarks in the *Forum*, is a matter of special importance. It is absurd to expect the average politician or "practical" man to be able to deal properly with complicated questions of administration —of schools, parks, charitable institutions, hospitals, docks and sanitary matters—all of which require special training and experience to do them justice.



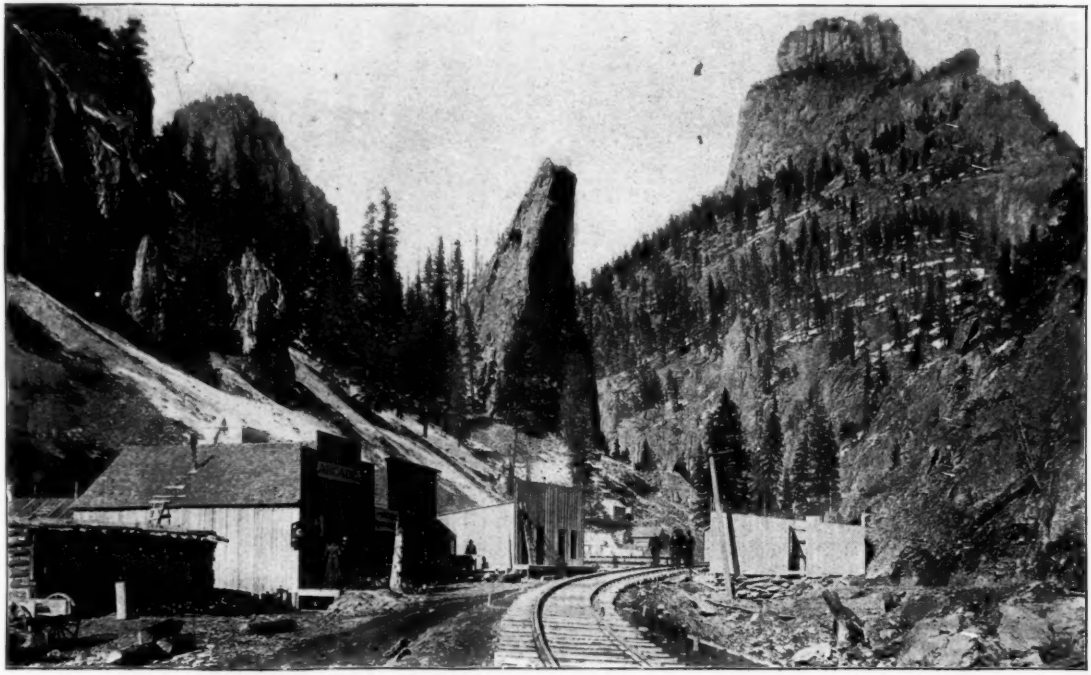
THE IN-COMING TIDE—CREEDE, COLORADO.

CREEDE, A NEW MINING CAMP.

By Albert Williams, Jr., E. M.

ALTHOUGH Creede seems a very new camp, measured from the time when it began to attract general attention, say in December of last year, its history really dates from the discovery of the Holy Moses mine, June 26, 1890; and months before the newspapers or the public had begun to notice it, shrewd mining men had found it out and had backed their faith in it by investing heavily, while a railway extension had actually been put in before the excitement and the rush occurred.

N. C. Creede, an experienced prospector who had been roaming the mountains, not only of Colorado but of almost the whole West, for many years, making numerous discoveries, though none which had brought him over $5000—the amount that his discovery of the Monarch district is said to have netted him—had become especially familiar with the San Juan and Gunnison country of Colorado. In 1889 he had been prospecting not far to the north of the site of the new camp, and had found what he considered "indications" (which would be rather hard for a prospector to define, but seem to be felt instinctively—at least that is the explanation given after they have been shown to be reliable), pointing across the range. Guided by this instinct, impulse or fancy, early in the next season, in company with G. L. Smith, he crossed the divide between the Gunnison and the Rio Grande; and the day after the first camp was made he had located the Holy Moses and Cliff claims. The name Holy Moses, by the way, does not involve any story whatever, notwithstanding the versions which have got into print. It was chosen simply as being new and striking. Certainly the Holy Moses is the first of the name. There is a story, however, about the finding of another great mine in the district. One of a party of later prospectors who had been working on Campbell Mountain (on which is the Holy Moses) had lost three burros, and following them across the deep gorge and up the steep side of Bachelor Mountain, made the Last Chance strike while resting from the climb. Creede himself immediately took up the extension of the Last Chance as the Amethyst. Many romances have appeared in the newspapers about the fortunes of the early locators,



THE RAILWAY TO THE CAMP—CRKEDE.

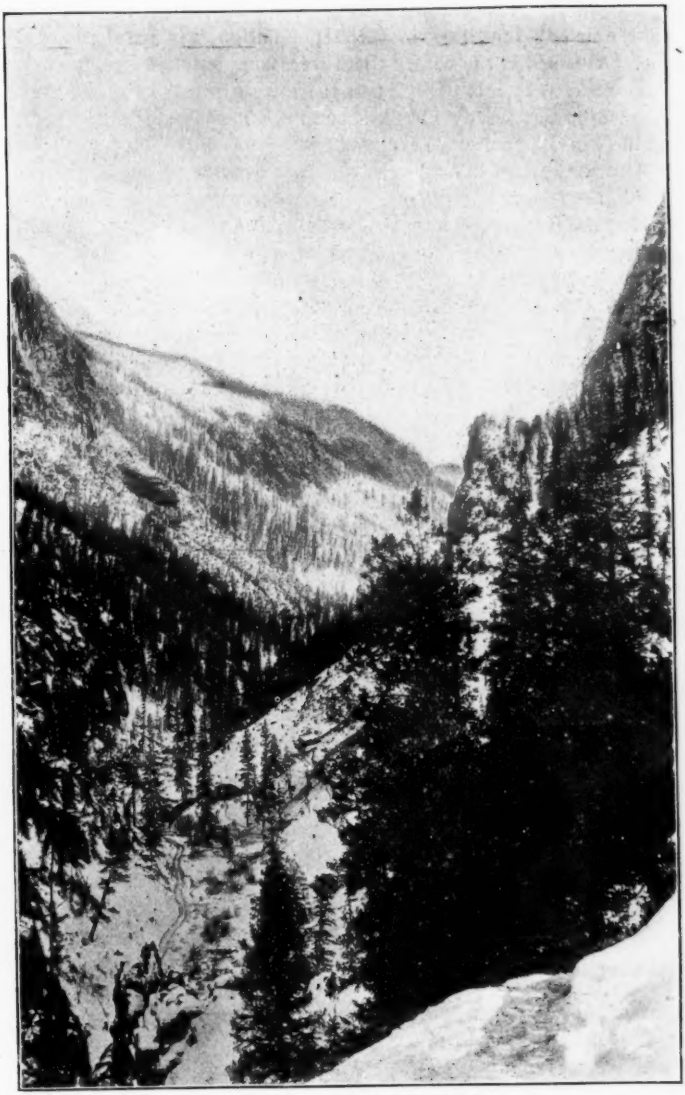
and there is nearly as much tradition afloat already about events which happened only two years ago as though they belonged to '49, '59 or '78. It is enough to say here that, contrary to the usual run of mining history, several of the Creede pioneers have become very wealthy men.

In the autumn of 1890 capital took hold, and development began in earnest. It was the enterprise of Mr. D. H. Moffat, at that time president of the Denver and Rio Grande railway, that gave the first impetus, when he and his associates went quietly to work, with ample means, to test the merits of the new camp. In the spring and summer of 1891 more prospectors and miners flocked in, followed by a few small storekeepers and others, and a little collection of cabins and tents sprung up, but as yet there was not a ripple of popular interest, and what notice was paid outside was rather derogatory than otherwise.

Later, when the regular shipments of high-grade ore coming to the smelting-works became generally known, there was more talk about Creede. The newspapers, awaking to the idea that something had happened, made up for previous silence by printing the most sensational reports under flaming headlines; and from mouth to mouth the rumors grew. During last winter there were many thousand men out of employment in Colorado, and among them a stampede began. It was not, however, on the scale of the great mining rushes of former times, and the character of the people in it was different. Of the throng, only a small proportion were old miners, for these realized that prospecting in a region like Creede in winter is a rather hopeless undertaking. However, enough men were out to cover the whole neighborhood with "snow-stake" locations, overlapping each other about three deep in spots. Such claims, without actual mineral discovery and not properly laid off, may be worthless in law, but will give rise to much trouble and litigation. During this irregular winter prospecting not much additional knowledge of the conditions and extent of the mineral-bearing area was gained; and while groundless reports of rich strikes were given out almost daily, very little effective surface work was done, or indeed was possible. Work underground in the mines which had been opened was meanwhile steadily pushed, and the extraction and shipment of ore continued under disadvantages, but with the result of showing that at least in certain ground were very valuable ore bodies.

The height of the fever, at least up to the present, was perhaps

FRONT VIEW OF THE HOLY MOSES MINE—CREEDE.



HOLY MOSES CROPPINGS—CREEDE.

in February. It is impossible to say how many persons were in the district at any one time, since the population was a truly floating one. At times in the winter there were supposed to be anywhere from 5000 to 10,000. On May 1 there were pretty certainly 7000, with slight but steady increase; and when the spring has fairly set in (June) a new set of incomers may be looked for.

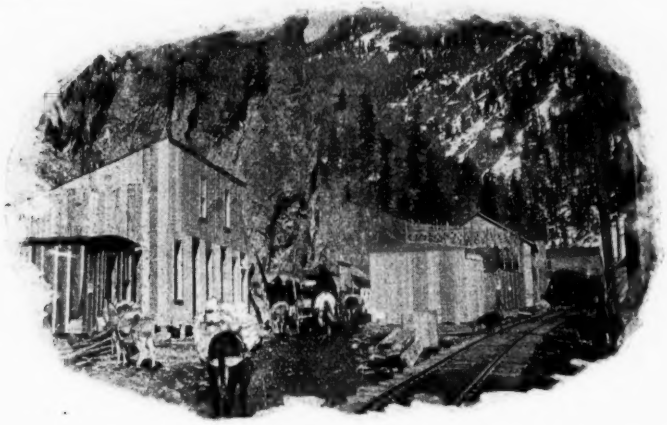
Crowds flocked in as fast as the hard-worked narrow-gage road could bring them, and other crowds went away, either disappointed or because their curiosity was satisfied. Of the swarm a great many were seeking work, of which there was but little, notwithstanding the bustle, and wages for common labor were low, in comparison with the cost of living. Much hardship was met, and not a few considered themselves lucky in being able to get away. Many people went to see what opportunities there were for engaging in business; some without any definite notion, but ready to enter upon anything that promised large returns from a small capital. Those who succeeded best at first were the owners of lodging-places, saloons and gambling-houses, and there was the usual influx of hard characters of all sorts. Yet the camp as a whole was remarkably free from scenes of violence. The old-timers called it "a tenderfoot rush."

Creede proper and Amethyst (at first called Jimtown), or Upper and Lower Creede, are in a very narrow gulch, with at places walls of almost vertical rock, and with a creek flowing through it. There was therefore very little room for the habitations of so many, and sites were in demand. An indiscriminate scramble for lots arose, and during the wildest period of speculation in them some very extraordinary figures were reached, in one case $15,000 being reported paid for a peculiarly eligible site. Some of the accompanying illustrations are from photographs taken in February and March and show the ingenuity with which builders found room to plant their little unpainted pine shanties or cabins or tents. Since then, however, the appearance of the camp has materially changed and now there are numbers of well-built houses, hotels, and stores. The real-estate "boom" has collapsed, and affairs have settled down to a quieter tone in other respects. For all its roughness Creede early boasted of many modern improvements—a water-supply, electric lights, banks, and two daily newspapers and a weekly.

Creede is in Hinsdale county, in what is known as the San Juan country of Colorado—a region already showing many famous mines, and promising as it becomes more thoroughly prospected to furnish

UPPER CREEDE.

many more. Indeed a moral of the Creede discovery is that the new camp is not in an altogether out-of-the-way spot, but almost touches the old Sunnyside district and certainly has been run over by prospectors many times before. The topography is extremely rugged, the escarpments abrupt, and snowy peaks near-by rise to from 10,000 to nearly 14,000 feet. Such regions are not merely the geological habitat of mineral veins, but the immense exposures of rock masses afford natural vertical sections of many thousands of feet, and the very ruggedness that makes climbing arduous facilitates the search of the prospector by preventing large accumulations of detritus, so that the veins are more likely to crop out boldly than to be covered by wash, as are the blind veins of gentler mountain regions.



ALONG THE CAÑON.

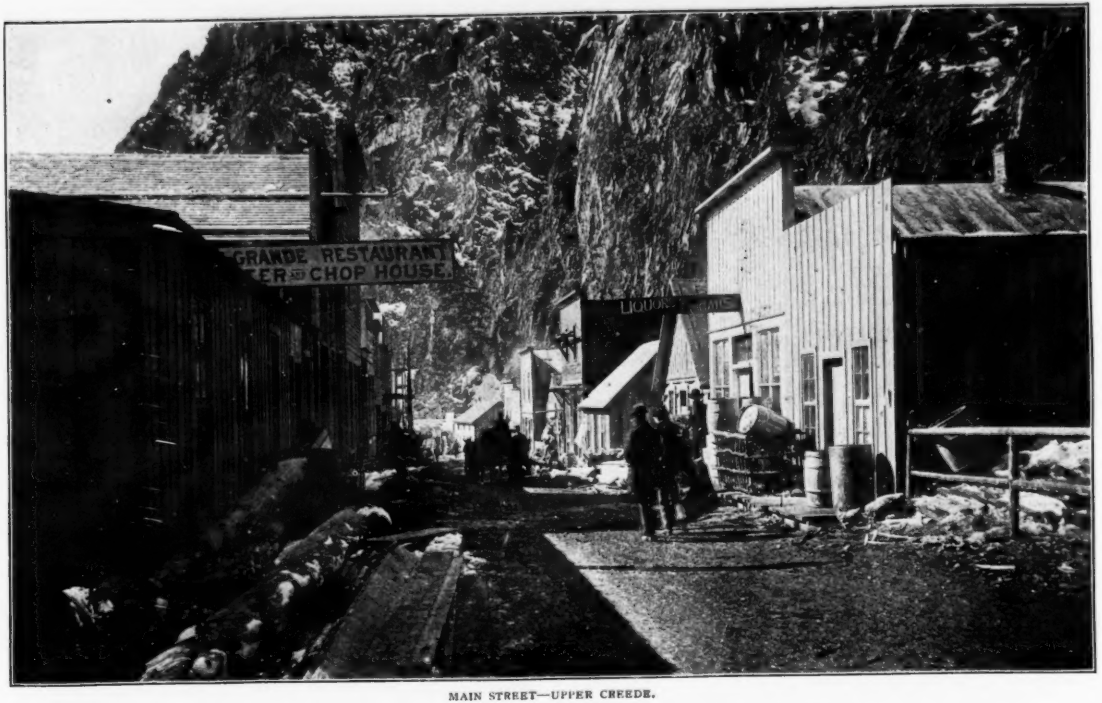
Geologically, little is yet known in detail of the region; but speaking generally it is a country characterized by heavy flows of the acid eruptives, of which rhyolite, trachyte, quartz-porphyry and the andesites are types. The miner's old name for this group of rocks, "porphyry," was a good generic term, readily understood. Now that he is beginning to attempt greater precision and give each species some definite lithological name that sounds "scientific," there is some confusion in description. At Creede there appear to be three or more varieties of the porphyry, probably indicating successive flows, and these are supposed to rest upon the limestone which also shows in the district, which latter may be part

STREET SCENE IN LOWER CREEDE.

of the great sheet of carboniferous limestone found in the Aspen and Leadville districts beyond. So far, two widely separated, nearly parallel fissure veins, with a northwest strike and a dip of about 35° to the west, have produced practically all of the ore. These are the Holy Moses and the Last Chance-Amethyst veins, and extensions along the course of both veins, beyond the end lines of the producing mines, have received much attention. There are other known veins, but their relations are not yet well understood. So little development has been made yet that it is a matter of speculation what future work will disclose, not only as to the question of ore, but regarding the structural relations. Besides the claims on these veins, there are also numerous prospects in the limestone.

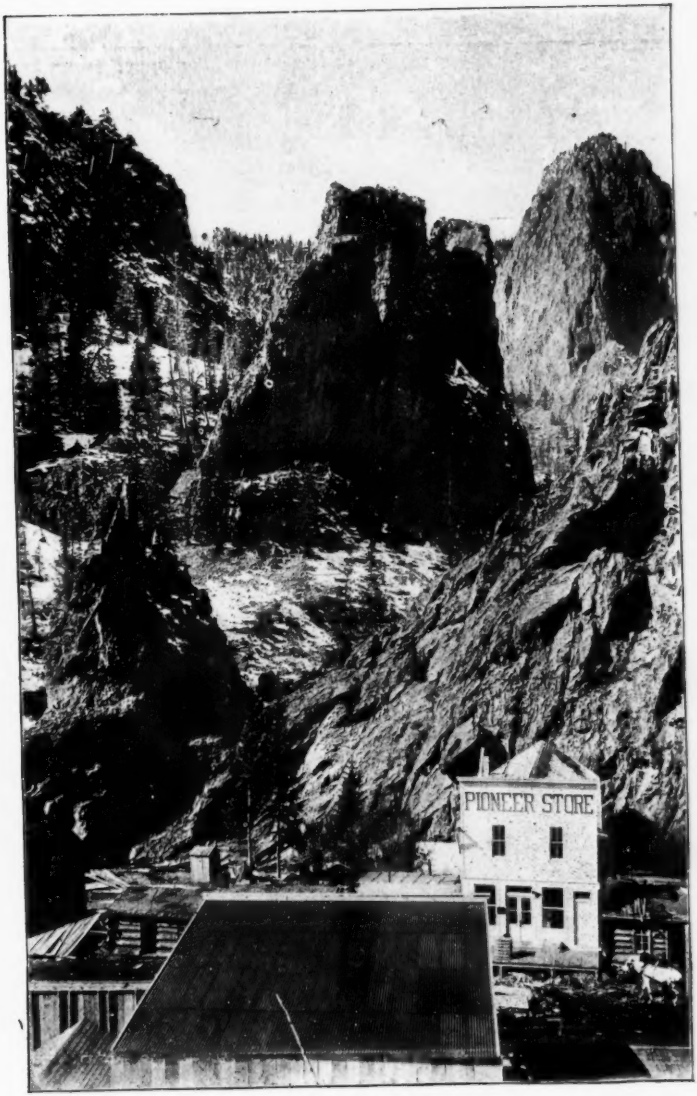
The bulk of the ore so far shipped and exposed in the mines has been a dry (siliceous) silver ore containing mere traces of gold, carrying iron and manganese, and but very little lead. The ore of the Ethel, however, is a heavy lead ore. Some very high-grade ore has been encountered, but the ore shipped has been the regular run-of-mine, without sorting. Carload lots have ranged between 80 and 150 ounces per ton, an unusually good average for unclassified ore in such quantity. Almost no stoping has been done in either of the two principal ore bodies, all the ore having been taken out in sinking and running levels while opening the mines, so that the producing mines present the peculiarity of having no waste dumps. At first all the ore had to be packed by burros down the steep grades to the railroad. A wire cableway was then put in at the Holy Moses, and soon another, to bring ore down from Bachelor mountain. These cableways are of great utility all through the western mining camps, and they span some decidedly accentuated scenery. The daily ore shipments from Creede in January were about ten carloads; at the close of April they were thirty carloads; but with the further opening of the mines and systematic stoping, together with increased cableway facilities and the use of machinery at the mines, the daily output will be larger.

Considering the disadvantages of winter work at the high altitude, the mines have been developed with fair speed. The conditions have been such that there was no call for heavy hoisting-plant at the outset, and no attempt was made to increase the working force beyond what there was convenient room for. The producing mines are controlled by Colorado capitalists who have had large experience and may be counted on to handle their own properties judiciously. It should be added that these men cannot be accused



MAIN STREET—UPPER CREEDE.

NEAR THE POST-OFFICE—UPPER CREEDE.



SOUTH WILLOW CAÑON, NEAR CREEDE.

of booming the camp, since they had reason to be satisfied with having taken off the cream of the district. The boom may be ascribed rather to the common impulses of ovine humanity, and the outside papers which encouraged it in such an unreasoning way did so innocently and from mere lack of good journalistic judgment. One cannot say so much of the railroad, the ticket-scalpers, and all the people who had their little axes to grind, especially the claim- and lot-speculators—but then that, too, was human nature. Much less excusable booms and boomlets are now to be looked for. A large number of mining companies to operate at Creede have been incorporated ; and it is safe to say that the usual proportion of the organizers will be found to have gone in with the intention of

AT THE SUMMIT.

making money out of the stock and not out of the ground. Eastern and European investors will have many such schemes laid before them in time. Not that all enterprises seeking capital for development work and plant are to be so classed ; still the presumption is that promising openings for mining investment do not go begging in a State where most of the home capital has been made in mining and where there are so many men who know a mine when they see it.

Creede has been puffed recklessly ; and on the other hand it has been perhaps unjustly decried by the disappointed ones. As in similar cases the truth probably lies between the extremes. Summed up briefly the situation is about this : The camp, taken as

a unit as it stands, is undoubtedly a good one, and its output this year may place it in the third rank of Colorado districts—and that is saying a good deal for a newly-opened district. But so far it has not been a "poor man's camp"; the plums have been too few. The mines on the two known ore chutes are yielding well, and have large reserves blocked out, which from the regularity of the formation their owners are able to estimate with greater accuracy than is usual in performing that extremely unreliable operation called measuring ore in sight. What they have beyond, they do not know themselves. As to the rest of the district, the prospects in the veins in the eruptive rocks and the prospects in the limestone—well, these claims are just like other prospects. Only by sinking, tunneling and the use of the diamond drill will their value or otherwise be determined. A great amount of exploratory work will be done during the remainder of the year, after which a good deal more will be known about Creede than is known at present.

ROPES PASS, TEXAS.

By William Kent, M. E.

IF upon a map of the United States we draw a line nearly north and south through Kansas City, along the eastern boundaries of Texas, Indian Territory, Kansas, Nebraska and South and North Dakota, we shall find that the States and Territories lying west of this line are those that produce the great grain crops of the country, that raise the most of its cattle, and produce nearly all of its precious metals, and most of its copper and lead. The great transportation problem of all this vast section is, how shall its products most easily reach a seaport where they can be loaded upon Atlantic Ocean steamers. If the map be studied further it will be observed that if distance to a seaport were the only feature in the problem, that seaport must be located on the Texas coast, in the western part of the Gulf of Mexico. The extent of territory naturally tributary to a Gulf port has been shown by Professor L. M. Haupt, of the University of Pennsylvania, who divides the United States into five great transportation basins, each tributary to its own base of water-transportation, as follows:

Atlantic Ocean Escarpment	550,000 square miles area.
Great Lake Basin.....	500,000 square miles area.
Mississippi River Basin.....	300,000 square miles area.
Pacific Slope.....	700,000 square miles area.
Great West Gulf Basin.....	1,000,000 square miles area.

But as a large portion of the bulky products of the Pacific slope seek an outlet to the Atlantic, rather than to the Pacific, the area of this slope should also be considered as partially tributary to the Gulf. Also all that portion of Mexico lying north of an east-and-west line drawn fifty miles north of the extreme southern corner of the United States, at the mouth of the Rio Grande, an area of about 300,000 square miles, should find its natural eastern outlet at some point in the Gulf of Mexico within the coast-line of the United States. Thus we have an area of say two million square miles naturally tributary to a Texan port. This condition alone would long ago have caused the building of a great city upon the Western Gulf but for one hindrance, namely, that there is not upon the Gulf a single good harbor for deep-draught vessels.

In any other civilized country this hindrance would have been removed by the Government digging and maintaining an artificial harbor, but our Government moves slowly in matters of this kind and it is only recently that an attempt has been made to create such a harbor in a way commensurate with its importance. Some millions have been spent in years past at Galveston in the vain attempt to give that city a depth of water over its bar of more than twelve feet, but the money being doled out in limited amounts at a time, the work done by the engineers was destroyed by the teredo and by the storms and shifting sands. A year ago a new appropriation of $6,000,000 was made for that harbor, and it is to be hoped that with the knowledge of the difficulties of the undertaking gained by past experience, the money will be spent wisely in building works of a permanent character. The great importance of a deep-water Gulf port to the great West was forcibly shown by a "Deep-Water Convention" held at Denver, Colorado, in August, 1888, in which thirteen States and Territories were represented by more than six hundred delegates, presided over by Governor Thayer, of Nebraska. A similar convention was held in Topeka, Kansas, in October, 1889, at which seventeen States and Territories were represented. It was presided over by the late Senator Plumb. The memorials presented to Congress by these two conventions and the general attention they awakened undoubtedly had great influence in securing the large appropriation for Galveston harbor, already mentioned. The latter convention in its memorial stated that a harbor on the Texas coast would afford a saving in freights to the trans-Mississippi region amounting to $120,000,000 per annum.

While conventions were agitating for Governmental aid, and while Congressmen were deliberating, private enterprise actually undertook the solution of the problem, and with such energy and talent that probably long before the harbor of Galveston has had its Government jetties built, another seaport will have been established with deeper water, and have become the principal port of the Gulf, to which its location entitles it. In 1888 Colonel E. H. Ropes of New York, while visiting Texas in search of health, made a study of the several points on the Texan coast which had been suggested as the best locations for a deep-water harbor, and came to the conclusion that the city of Corpus Christi possessed many advantages over all the other points named. Chief of these were its location at the extreme western reach of the Gulf, at a

point where ocean steamers could sail to a longitude west of that of Omaha, and where a railroad to the nearest point on the Pacific —San Diego, California—would be shorter than any other that could be built from the Pacific to the Gulf, viz., only one thousand two hundred miles; and the fact that at that point deep water could be secured at less expense and in a shorter time than at any other.

As to the location of Corpus Christi, with reference to the great transportation basin of which it is expected to be the outlet, it may be said that it is 800 miles nearer to Denver than any Atlantic port is, 500 miles nearer Kansas City, 250 miles nearer St. Louis, 400 miles nearer Omaha and 1000 miles nearer Santa Fé. Corpus Christi is situated upon a land-locked bay, nearly circular in shape, of about one hundred and forty square miles in area, and with a depth of water throughout a large part of its extent of about fourteen feet. A tortuous channel leads from the eastern end of this bay, to Aransas Pass, about thirty miles from the city, which pass is obstructed by a bar over which there is eight feet of water.

THE GREAT TRANSPORTATION BASINS.

The map on page 345 shows the location of the city and its surroundings. In front of the bay, separating it from the Gulf, is a long island of sand and clay called Mustang Island, the topography of which consists largely of sand hills from twenty to fifty feet high. Aransas Pass is at its northeastern end, and it is reached from the city by the tortuous channel above mentioned, which extends around the eastern end of Harbor Island and between it and St. Joseph's Island, instead of through the passage between Harbor Island and Mustang Island as might be supposed from the map. At the southwestern end of Mustang Island is a narrow and shallow pass called Corpus Christi Pass, separating it from the island to the southwest known as San Padre Island. Mustang Island is separated from the mainland, at its southwestern end, by Laguna Madre, which is three-and-a-half miles across, at the point on the map where are the words "Deep Water Terminal Railroad," but it is only one-and-a-half feet deep on the average.

A peculiarity of the passes at the ends of Mustang Island, which is common also to all the similar passes from Galveston southward, is that they shift their positions gradually toward the southwest, being thus influenced by the action of the currents and storms. "The constant pressure of the outgoing current through the passes upon their southerly sides has a double action," says Colonel Ropes. "It carries the channel constantly around towards the southwest, precisely as the spokes of a wheel revolve around the axle. The channel, as it breaks out during a heavy storm, debouches at a right angle to the coast, but is immediately seized, as it were, by the littoral current at the outer end and pressed against the southerly bank, which it wears away constantly until the course of the channel has been bent down the coast, and presses against the shore of the southern boundary of the pass. Here it holds its position, sometimes for months, sometimes for years, until a new storm breaks out a new channel again at a right angle to the coast line, to be in turn worked southward like its predecessor. Each of these passes in its natural state, therefore, shows a series of fan-shaped channels, and the theory of the jetty system is, that by holding the water to one course, these channels merging into one will produce the desired depth of water. The second action of this littoral current is to so press the out-going volume of water against its southerly shore that it wears away the head of the southerly island, carrying the sand out to sea, where it is caught by the waves and thrown shoreward again by the southerly winds, depositing it

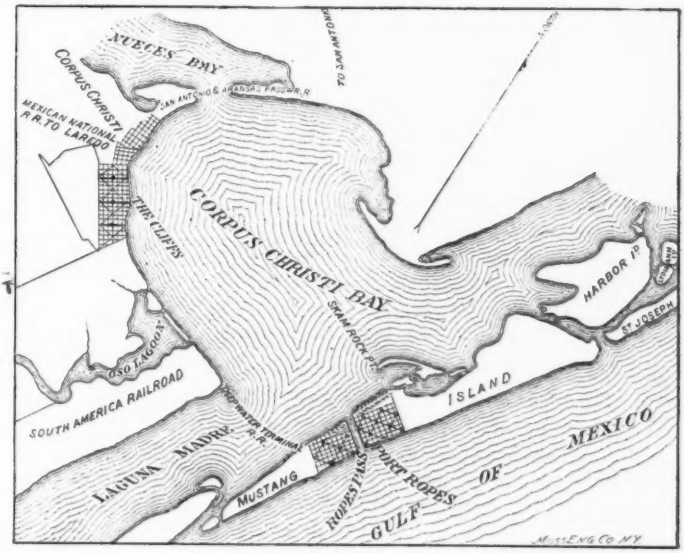
at the foot of the island which constitutes the northerly shore of the pass. Thus all these passes have been found to be working steadily in a southerly direction, the southerly island retreating, and the northerly one advancing at the same rate. In 1853 the Aransas Pass light-house was built directly behind the center of the Pass upon a sunken island known as Harbor Island. That light-house stands to-day nearly two miles north of the center of the Aransas Pass of to-day."

After residing at Corpus Christi for more than a year, making a careful study of the hydrography of the surroundings of Mustang Island, Colonel Ropes came to the conclusion that the best way to obtain a deep-water harbor for a seaport was to cut a channel directly through the island, and make a new pass. He selected a point where there were topographical evidences that there had been a channel cut by nature many years ago, and where thirty feet of water in the Gulf could be reached with a minimum amount of cutting. He organized a company which has now been at work for about a year cutting the channel. Work was at first done by removing the sand hills down to the high-tide level, by teams, plows and scrapers, and by a steam-dredge, cutting its way from Corpus Christi Bay, and making a canal for itself as it proceeded. A small channel was then dug in advance of the dredge to the Gulf, through which the waters of the Gulf and the Bay were united. In regard to the present condition of the work, a recent letter from Colonel Ropes contains the following :

"The length of the cut across Mustang Island is 10,000 feet, of which all but 1350 feet has now been cut. The first cut is only of sufficient width to pass through a single large vessel at a time ; the purpose being to widen artificially afterwards, which operation will receive great aid from the scouring effect of the currents. The space ahead of the dredge has been cut down to the level of high tide in the Gulf, penetrating hills twenty-two feet high. A small trench has been cut along the north side of this excavation, through which the waters of the Gulf and Bay already mingle with every tide. The Gulf end of this trench is protected by temporary jetties consisting of wooden caissons each twenty feet long, four feet wide and five feet high, extending across the beach out to low water; and weighted down with cement rock made from beach sand mixed with Portland cement in proportions of six to one. These caissons are found to answer admirably and to withstand the pounding of the waves even better than was expected. They were built for the purpose of as-

certaining what effect the sand movement would have to fill up the channel from the front. The result has been highly gratifying. So long as the jetties stood intact, there was not only no fill between them, but the trench actually became deeper by the means of this small stream of water passing through. During a storm tide, the waves worked around the shore end of the south jetty and swept in the sand which moves laterally along shore ; filling the trench at the crest of the beach. This was of course remedied by extending the jetties further up the beach, and no further fill has resulted. This proves that the only thing to be guarded against in the deterioration of a sandy entrance is the movement of sand along the coast line parallel with the beach. The amount of sand brought in directly from the front by the waves is very small comparatively, and is taken care of by the current passing through the outlet.

"Rock is now arriving by vessels for the first jetty. The schooners sailed from Corpus Christi Bay, one-and-three-quarter miles up the Pass, and discharged their cargoes within one-quarter mile of the Gulf beach. The first jetty constructed will be a drowned jetty thirty feet in width at bottom and one yard high. This will be placed in prolongation of the north bank of the channel, the object



MAP SHOWING LOCATION OF ROPES PASS.

being to produce an overfall with its resulting scour ; and will extend out to the twenty-foot depth in the Gulf. Experience on sandy coasts where the heavy drift is all from the North, as it is on this coast, has shown that a drowned jetty producing an overfall results in scouring a trench upon the south side of the jetty from six to nine feet below the normal depth and from 200 to 400 feet in width. This effect was produced at Galveston ; at Aransas Pass, and at Brazos Santiago, when the Government was constructing jetties at this point, and before the jetty was built up above overfall. This result is astonishing to the unprofessional mind.

" Rock can be placed in these jetties at a cost not exceeding $3 per yard, so that the cost of a drowned jetty will be very slight and will open the Pass within a few months to vessels drawing from twenty to twenty-four feet of water. After the Pass has been thus opened the work of constructing a high jetty will be carried forward and pushed out to thirty feet of water. This will be placed on top of the drowned jetty. Dockage for heavy-draught vessels will be furnished in the Pass itself, which will afford room for sixty-six first-class ships at one time. This can be extended by means of piers and basins to any desired extent. Mustang Island, at the west side, is very low, and portions of it are subject to overflow, and the project is to place the slips there when they become necessary. The commerce will be met by a terminal railway down Mustang Island to a point opposite Flower Bluff, the nearest point on the mainland, thence crossing to the mainland over a hard, sandy bottom, having only from twelve to eighteen inches of water upon it, except at two points where there are navigable channels which will be bridged. The distance across from Mustang Island to the mainland at this point is about four miles ; and the entire distance to Corpus Christi, following the contour of Corpus Christi Bay, is about twenty miles. Lighter draught vessels, such as draw fourteen feet or less, can now cross Corpus Christi Bay, which has a general depth of fourteen feet and upwards. This is a greater depth than is ordinarily found upon Galveston bar, so that with the opening of Ropes Pass, any vessel which has crossed Galveston bar will be able to sail at will over 141 square miles of Corpus Christi Bay. It may, therefore, be expected that all vessels which can come up to Corpus Christi will do so, in obedience to that law which sends commerce as far as possible by the cheapest rate. Vessels chartered from New York or any distant point will charter for Corpus Christi dock at the same price as for Ropes Pass docks."

As might be expected in view of the far-reaching interest in securing deep water for a Texas port, there is intense rivalry between different points on the coast as to which shall soonest secure the coveted deep water, either by means of Government appropriation or by private capital. A company has been at work at the mouth of the Brazos river for three years past, and last summer succeeded in deepening the entrance to that stream to seventeen-and-three-quarter feet, where the depth had been but four-and-a half feet. This had been followed by a tremendous rush of investors to a new town just started near the mouth of the river. The first building lot in the town was sold July 8, 1891, but by the month of November the sales were reaching $200,000 per month and upwards. This interesting fact shows how strong is the faith of the trans-Mississippi region that deep water will be followed by an immense commercial city. Galveston, with its large Government appropriation, and its reputation as a port of entry already established on only thirteen feet of water, is expecting that it will have thirty feet at no distant day. Sabine Pass, at the eastern boundary of Texas, has had already $550,000 of Government money spent upon it, and an official estimate of the cost of completing the jetties at this pass is $2,301,250, which amount is not likely to be granted for many years. Pass Cavallo, 100 miles south of the Brazos river, has had $290,000 spent upon it, and the Government plans contemplated an expenditure of $3,826,000, which is also indefinitely postponed. The original Government plans for building jetties at Aransas Pass, one from the head of Mustang Island, and the other from the foot of St. Joseph's Island, called for an expenditure of $1,571,000.

The following data are given as a comparison of the difficulties to be overcome in reaching deep water at the several points now under consideration. According to Government surveys the distance to thirty feet of water in the Gulf at Ropes Pass is 650 feet less than it is to twelve feet of water at Aransas Pass, eleven miles further north. At the Brazos the distance to be built from the outer end of their jetties to thirty feet in the Gulf is 1½ times as great as from the Port Ropes beach to the same depth. The Port Ropes project calls for about 5500 feet of jetty altogether, counting both sides; at Galveston the requirement is 54,000 feet of jetties. The distance from the nearest point of the deep basin of Corpus Christi Bay to the Gulf beach at Ropes Pass is two-and-one-third miles; while from the beach at Corpus Christi Pass to the nearest point of the same deep basin, is over seven miles, and from Aransas Pass more

than eleven miles. The distance in altitude between the two bodies being the same measured any of these ways, gives a slope three times as steep through Ropes Pass as through Corpus Christi Pass and five times as steep as through Aransas Pass. This shows which of these Passes will close up, if any closes. It shows, too, which will scour out the deepest.

Mr. H. C. Ripley, the chief engineer of the Port Ropes Company, who for eighteen years held the position of United States Assistant Engineer upon the Texas coast, and is probably the best authority living upon the topography and hydrography of the coast and upon the deep-water problem, made an inspection in November and December, 1890, of the Port Ropes project. It included a complete survey of the site of the proposed works, and a thirty-days' record of the tidal fluctuations in the Bay and Gulf. In an elaborate report dated March 14, 1891, he expressed the conclusion that the scheme if properly executed would prove entirely successful. He states that Corpus Christi Bay is undoubtedly the finest tidal basin on the Gulf coast. The project he considered gives a channel across the island 10,000 long, and 1000 feet wide, with jetties at the Gulf end 700 feet apart ; the north jetty extending to the thirty-foot depth, a distance of about 4000 feet from low tide mark, and the south jetty extending to the twelve-foot depth. The following is an extract from his report :

"This slope would develop in the proposed channel a velocity of 4.21 feet per second and a discharge of 82,000 cubic feet per second. To the unprofessional reader, these figures will possess little meaning. It will be well, therefore, to make some comparisons with other works where successful improvements have been made. At Malamoco, on the Gulf of Venice, where the tidal fluctuation is but 2.25 feet at spring tide and the area of the tidal basin but sixty square miles, there was developed a channel depth of over thirty feet at mean low tide by means of two jetties, one of which was 7200 feet long, placed on the north side of the channel ; and the side from which the lateral drift comes ; and the other 3230 feet long, placed on the south side and extending out to within about 1400 feet on the line of the north jetty. At South Pass, Mississippi river, where the jetties are 700 feet apart, and the average discharge is 24,000 cubic feet per second at low river and 75,000 cubic feet per second at high river, there is maintained a channel depth of thirty feet at average flood tide. At Ropes Pass, the average fluctuation of the great declinational tides is 2.30 feet ; the average discharge will be 63,000 cubic feet per second ; the maximum discharge 82,000 cubic feet and the area of the tidal basin is 141 square miles. It will thus be seen that Ropes Pass possesses conditions more favorable than either Malamoco or South Pass, and these improvements are among the most successful in the world."

Work is now being pushed vigorously upon the Pass, and it is

expected that a few months more will witness the formal opening of this important outlet to commerce. Connected with the Port Ropes project is that of building a terminal station for the Corpus Christi and South America railroad, which is projected from Corpus Christi one hundred and fifty miles southward to Brownsville, on the Mexican border. A glance at the map will show that the shortest line for an international railroad from the United States to the City of Mexico, forming one of the links of the great international railroad to South America, passes through Corpus Christi and Brownsville. The former city therefore commands the position of being at the same time the best point for a port of entry and a commercial city, the only point in the United States where the international railroad will touch a deep-water seaport, and the eastern terminus of a railroad to San Diego, California—the shortest route across the territory of the United States for trans-continental traffic. Fortunately, also, the city is built upon a bluff, high above the reach of the tidal storms which frequently lay under water and devastate a large portion of the Texan coast, and its climate, cooled by the trade-winds that blow eighteen hours a day from the Gulf of Mexico, is one of the finest in the world. The city is already famed as a health resort throughout Texas and other States in the southwest. It is now the terminus of the San Antonio and Aransas Pass railroad, leading to the north and west, and of the Mexican National, leading westward to Laredo, and thence to the City of Mexico. A railroad is likely soon to be built to Brownsville, and others are projected to Eagle Pass, Texas, to connect with the Southern Pacific, and to Topolobampo, Mexico, the nearest point on the Pacific Coast.

THE MODERN MARINE BOILER.

By A. B. Willits, U. S. N.

THE marine engines, often things of beauty and always interesting in their steady, graceful and potent functions, receive all the praise when the ship is making or breaking a record. While it is not at all uncommon to find the ordinary commercial traveller versed in the technicalities of this portion of the machinery, and able to discourse glibly on the relative "horse-power" of the leading transatlantic liners, it is seldom that he has much knowledge of the boilers, those vast factories and reservoirs of that power of which he speaks, and which, in their hot and grimy compartments forward, giving but few signs of the intense strain they are under during every moment of the run, perform a duty not in the remotest degree indicated by a share of the glory of a successful trip. It is probable, nevertheless, that in the mechanical world to-day, more thought is being bestowed on the boilers than upon the engines proper; and far from being commonplace accessories, they are constructions of the most scientific character, combining in their proportions the results of the greatest range of experiment and deepest study. Each element is so carefully considered, both by itself and in its relation to the other parts, that the final outcome is an apparatus of elegance to the professional eye, and one in which strength, durability, accessibility and efficient capacity are adjusted to a nicety which satisfies the conditions imposed with regard to the production of a given power within a limited space and with a minimum weight of metal.

The boiler depicted in an accompanying engraving represents one of the main boilers of the United States man-of-war *New York*, now in the course of completion in Philadelphia, and is of greater dimensions than any previously built in this country. It does not differ in size, in any marked degree, from the largest built abroad for the ocean greyhounds, although the latter usually possess more heating surface in proportion to grate, to their economical advantage at full power. The structure is 15 feet 9 inches in diameter, and 18 feet long, and is "double-ended," having an exactly similar arrangement of furnaces and tubes in each end, only one of which is shown in the view. The tubes conduct

the hot gases and smoke of combustion from the backs of the furnaces to the fronts of the boiler, whence they are led to the smoke-pipe by light casings, attached after being placed on board-ship, this type being styled the "return fire tubular" or, more generally, the "Scotch" boiler.

The material is "open-hearth" steel, subjected to the closest inspection and severest tests before acceptance. The nine great sheets composing the cylinder are more than one-and-a-quarter inches thick ($1\frac{2}{8}\frac{1}{4}$) and weigh between five and six thousand pounds each. The flat-heads are thinner, but so closely stayed by heavy steel braces running from end to end, as to compensate for that. Indeed, if wholly unstayed they would have to be of simply monstrous proportions to sustain the pressure put upon them, something like ten inches in this case, which would be both impractical and absurd. Spherical ends would of course obviate bracing and ultra thickness, but the practical advantages of flat ends are retained by a scientific system of bracing.

This boiler weighs about seventy tons and contains eight furnaces, and 1148 tubes, aggregating nearly a mile and a half in length. These form the major part of the 5200 square feet of heating surface, as they are always surrounded by water to be evaporated. The quantity of water necessary to fill the boiler to a proper steaming height is about thirty tons, yet under forced combustion, such as is always used for full power, this is converted into steam at the rate of $\frac{1}{3}$ of a ton a minute, demanding a continuous supply from the pumps, at that rate, to maintain a safe level. The furnaces contain 165 square feet of grate, upon which is burned nearly three tons of coal per hour (about forty pounds per square foot per hour), with an air pressure of less than one-tenth of a pound per square inch above the atmosphere.

The steam pressure carried is 160 pounds per square inch above the atmosphere, quite the usual pressure for triple-expansion engines, but when it is realized that this gives a total disruptive strain on the cylindrical shell, of more than *six-and-a-half million pounds*, it no longer appears as ordinary but, rather, terrific; a force, too, which is not evidenced by the placid exterior of this veritable torpedo.

Taking the entire six main boilers of this ship, a brief summary of data is at least impressive and suggestive of the importance of these elements. Their net weight is more than four hundred tons, and they contain about *three quarters of an acre* of heating surface,

with eight-and-a-half miles of tubes. Their forty-eight furnaces will consume more than 400 tons of coal a day and evaporate 140 tons of water an hour to produce the 16,500 horse-power needed to drive the vessel twenty knots an hour. They will occupy a floor-space in the depths of the ship, 100 feet long by thirty-six feet wide (double that allotted to the main engines) and will require a force of a hundred men to properly attend to and manipulate them.

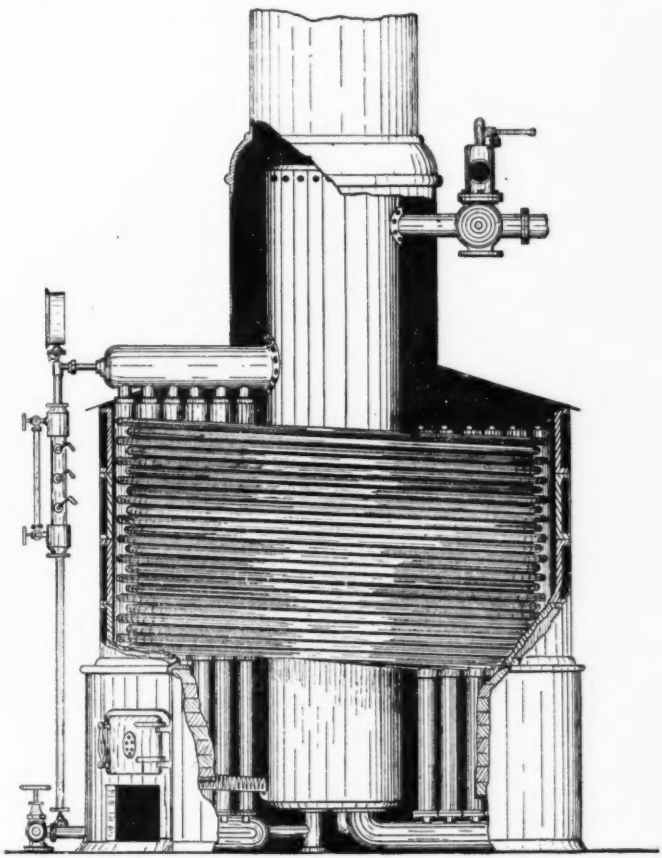
A contemplation of these few facts makes it obvious to any one that a high degree of skill and efficiency on the part of the attendants is important and necessary, and that the element of carelessness here would be as likely to cause havoc and disaster, as it would in the engine-room or on the "bridge." Eternal vigilance is the watchword, responsibility and anxiety being ever present with the performance of this unseen duty. It has been mentioned before that the boilers of the great ocean "liners" were proportioned with a larger ratio of heating surface to grate area than are those of men-of-war, and it is to this fact that the former show a more economical performance, by obtaining a given power on a lower coal consumption. Badly-informed writers have used this to animadvert upon the designers or constructors of war-ship machinery without troubling themselves to find a reason for the difference in results, yet it requires only ordinary reflection to perceive that the conditions in the two cases are wholly dissimilar.

The engines of mail steamers are driven to their full power, at all times, and the question of coal expenditure becomes of financial importance; hence their boilers are always designed especially for economy, and the necessary space in the ship is unhesitatingly taken. To follow this line in a naval vessel, of much less length for equal power, would incur a very excessive sacrifice of hull-room over that now given.

The adoption of forced draft has made it possible to obtain enormously greater evaporation from a boiler of ordinary design than was possible with natural draft, by reason of burning a much greater quantity of coal on the same grate. To do this economically, however, the heating surface, or surface of absorption of the heat from the gases of combustion, must be greatly increased, which means larger or more numerous boilers. The designers of machinery for war-ships have carefully considered the bearing and contingencies of this feature, and have adopted as efficiently proportioned boilers as the existing conditions justify. The assump-

tion is that the full power of this class of vessel never will be required except for short periods, when the production of it at the lowest rate of economy will not be vital; and a mean is considered advisable, where space is of such paramount importance. The quality of workmanship shown in the details of construction, with its guarantee of durability, is second to none in the world.

The desire of marine engineers is to produce a type of boiler which shall do away with the necessity of such enormously large and heavy shells, and present a lighter substitute which will per-



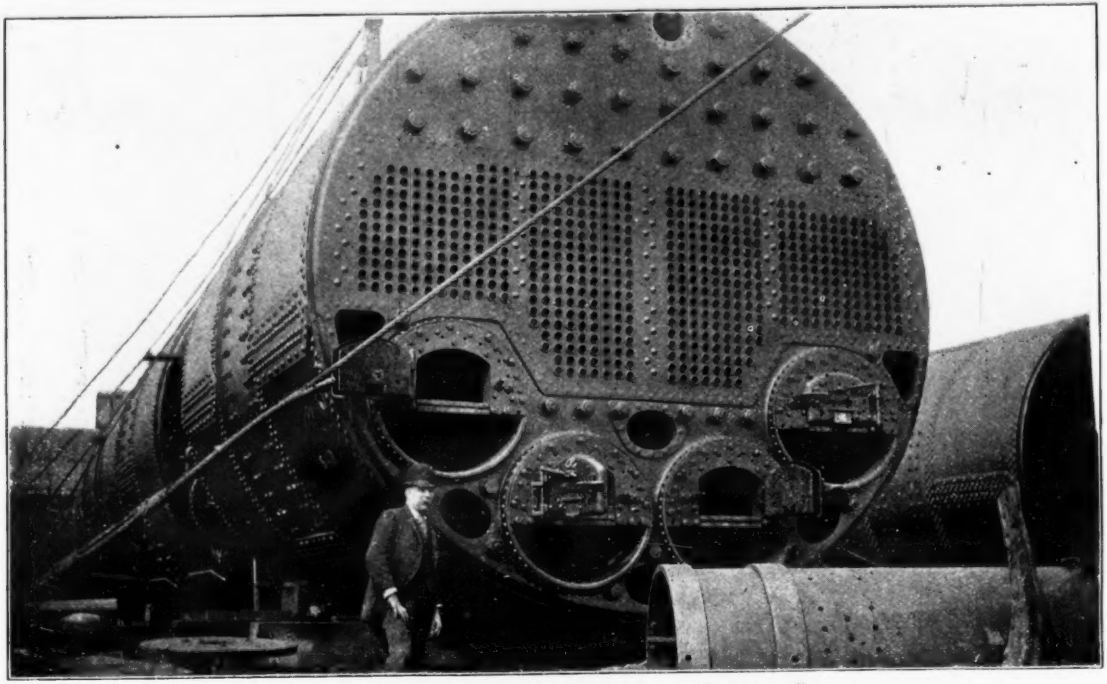
BOILER OF THE "WARD" TYPE.

form the duties of both envelope and heating surface conjointly. A very great reduction in size and weight is thus possible, and the numerous forms of tubulous boilers are the outcome of this desire which, year by year, is intensified by the gradual necessary increase in the proportions of the cylindrical type.

The tubulous boiler consists of numerous tubes of comparatively small diameter, and variously connected, inside of which the water circulates, and around which a light casing of metal, lined with refractory material, is built to confine the hot gases to action upon their outer surfaces. Thus the tubes become parts of the shell as well as continuing to be heating surface, and by reason of small diameters, even in the connecting drums, all very thick plates are avoided and the highest desirable steam pressure safely carried. The amount of contained water is also greatly reduced as well as much more effectively disposed for evaporation than obtains in the Scotch boiler, where the water is in solid bulk, much of it below all heating surface, and only brought to the boiling-point slowly or by forced circulation.

For years this tubulous form has found favor for use in smaller vessels, such as torpedo-boats or launches, but its adoption for larger ships has been delayed for reasons which, temporarily at least, counterbalance the evident advantages of less weight and size, better circulation, more efficient evaporation and the rapidity with which steam can be raised. One of these is that their very compactness militates against their accessibility for cleaning and examination, and it is feared that without a possibility of unusual care their decay will be rapid and their "life" short, when placed in the damper holds of deeper vessels, where their use will be interrupted by long periods of idleness. Besides this, the ready renewal of defective tubes is not perfectly provided for in most designs, and many practical difficulties have attended this work with the smaller sizes, despite a theoretical demonstration of the ease of such operations. Especially is this true after some considerable use, and indicates a probable trouble and incites caution in those who would like to abandon the bulkier but more accessible form.

Experiment, of course, is the only way to prove their real adaptability to the service required, and the Government has placed on board the United States Steamship *Monterey*, just built in California, four tubulous boilers of the "Ward" type, as the principal portion of the steam-generating machinery of that ship;



ONE OF THE MAIN BOILERS, UNITED STATES STEAMSHIP "NEW YORK."

a general idea of which may be obtained from an illustration accompanying this paper.

Of course much interest centers in the coming trial of these boilers, but upon the reports which shall be made by the engineers in charge, after a continuous experience with them under the various conditions of a cruise, will depend any verdict of value. The field is open still for inventive minds, as the perfect type has not yet been evolved. The study is in better shape now by reason of the many devices already constructed and found wanting, as their faults, as well as their points of excellence, serve to aid the designer in marking his lines for improvement.

TESTING GUNS AT SANDY HOOK.

By Frederic A. C. Perrine, D. Sc.

AT the end of a ride of an hour and a half from New York, on the tugs *Ordnance* or *Engineer*, lies Sandy Hook, famous in the tales of Captain Kidd and Cooper's story of the mysterious "Water Witch"; a spit of sand out in the Atlantic making, with Coney Island on the other side, the Lower Bay. Quiet and natural, it remains as when the first Dutchman sailed into the harbor. Here can be found the most varied flora of the Middle States, and here too are all the birds to be found which are known as American and which used to make tuneful the woods of New York's neighborhood, driven to this land of quiet by innumerable sportsmen, and supported on the berries of the cedar and bay which cover the peninsula.

For years Sandy Hook has been a Government reservation, and with the exception of the Light-House Keeper and the officers and men of the Proving-Grounds, has had no inhabitants except the telegraph operator in his lonely tower who records the winds and announces the incoming vessels. Yet to this lonely sand beach we now all turn for the latest news of our new army, as to the harbors and the ship-yards of the Hudson and the Delaware for news of the new navy. Not for tactics evolved and appliances manufactured, but here are made the truly scientific experiments by which the art is developed, which is every day rendering less and less useful the heavy armor of the unwieldy ships of modern navies.

Against the smooth-bore guns of ante-rebellion days the railroad-iron armor of the *Alabama* and the iron plates of the monitors proved effective, but at the close of the war methods of construction typified in the Rodman and Parrott guns had begun a new era of manufacture which has necessitated greater and greater thickness till the floating forts of to-day have but scant buoyancy in case of accident with armor which is but a poor protection against the high penetrating power of the guns. Nor is it simply great blocks of steel and high charges of powder which have made the modern gun; little by little strains and proportions have been worked out by these engineers until the modern ordnance engine has become a piece of mechanism beautiful in its lines of resistance.

The work of the Sandy Hook Proving-Grounds is not merely the mounting, loading and firing of the guns, nor is it an attempt merely to burst defective workmanship, but shot must be studied in flight and guns in recoil with their proper and improper charges of powder, until the engineer has the data for constructing the gun which will not burst and the carriage which will not break up or fail in its duty. To the stranger who visits the post from time to time, and sees from month to month the same guns in the same carriages, fired always in a like routine, there is little evidence of the work really done, and he does not realize that this work which is being done upon types is really determining the whole construction of our future armament. Yet such is the very work of these three or four officers who are firing from day to day guns great and little at Sandy Hook.

Essentially the testing of a gun is determining the speed of the shot and the pressures along the bore produced by different powders and charges ; the velocity of recoil, and hence the strains in the carriage. Such scientific study of a gun began in Count Rumford's time, when Benjamin Robins in about 1740 invented the ballistic pendulum. Just as you would know how hard you had pushed a swing with your hand to drive it for a certain distance up along its arc, so he had the musket balls of those days strike a heavy iron plumb-bob to which was bolted a wooden facing for the lodgment of the ball. A steel tape attached was dragged out beyond two clips and recorded the swing of the pendulum. Count Rumford himself used this pendulum of Robins, but as a check suspended the gun to be fired as a pendulum also, and so at each experiment had a record of the force of the ball and the kick of the gun which should be, as the action and re-action of Newton's law, equal and opposite.

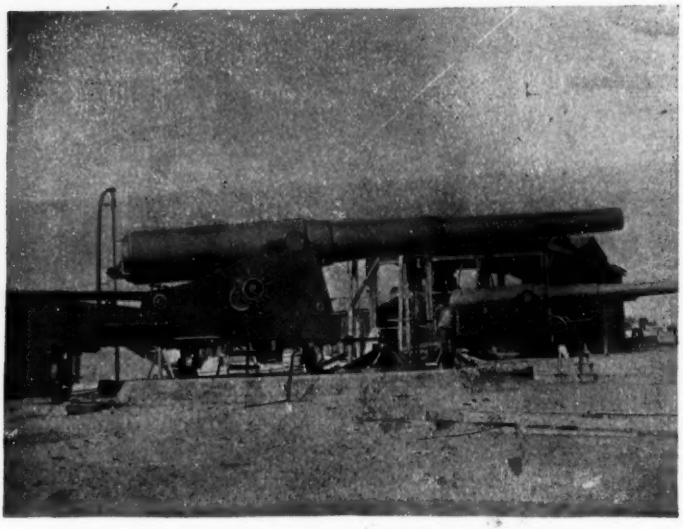
At various times this method had been used and improved in its details, until at last Major Alfred Mordecai, of the Ordnance Department, United States Army, constructed a ballistic pendulum weighing 9358 pounds. into which he could shoot balls varying from six to thirty-two pounds, from a gun which, with its suspension, had a weight of 10,500 pounds, but he reached about the limit of the capabilities of this method. It is too difficult to suspend on knife edges for free swinging greater weights, and for one of our modern high-power guns a pendulum would have to be supported weighing at least 400,000 pounds, surely enough to daunt any one from the engineering difficulties, aside from

TWELVE-INCH BREECH-LOADING RIFLE ON CRADLE IN TRANSIT FROM WHARF TO BATTERY.

the task of getting our farmers to favor the necessary appropriation.

It has not been only for the present time that the students of electricity have looked to it for a solution of all the most difficult problems, but since the infancy of the science we have found them to be men to whom the practicians have turned for advice, and naturally it was from this science of flying energy that the students of the flying projectile sought advice. We find about the time of the construction of Mordecai's pendulum in 1840, both Professor Henry of this country and Professor Wheatstone in England suggesting the solution of these difficult problems by the means of electricity.

Professor Henry's proposal was to drive at a high rate of speed a paper-covered cylinder on which the needles of two galvanometers were held by the action of currents passing through them and through wire screens which, when cut by the ball, would release the needles and so record the break. In plan this is the construction of the most accurate instruments of the present day. But it has been found too difficult to revolve the cylinders of record at such a speed and so regularly that the thousandths, ten-thousandths and hundred-



TWELVE-INCH STEEL BREECH-LOADING RIFLE MOUNTED ON PROVING CARRIAGE.

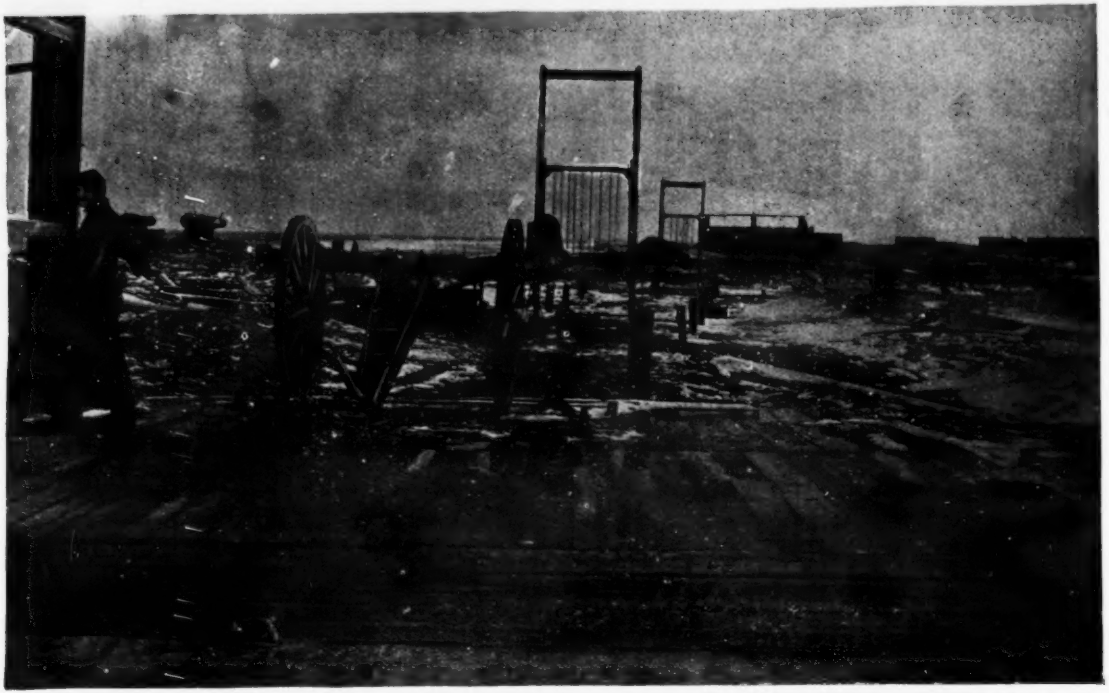
TWELVE-INCH BREECH-LOADING MORTAR MOUNTED ON EXPERIMENTAL CARRIAGE.

thousandths of a second might be accurately recorded, and on the polished steel or silver smoke-covered cylinder of the present machines is traced together with the record of the breaking of the screens, the vibration of a tuning-fork beating at each movement, the time in thousandths of a second.

But he is the greatest inventor who solves his problem most simply, and when Captain Le Boulengé, of the Belgian artillery, conceived the idea of recording the distance a body could fall in the time a shot was passing between the two screens to be cut, he had recorded a second on a length of sixteen feet, and had given a time record about twelve inches long for one of our modern high-power shot passing over a hundred feet of space, and had reduced the two records to lengths capable of being measured with equal accuracy.

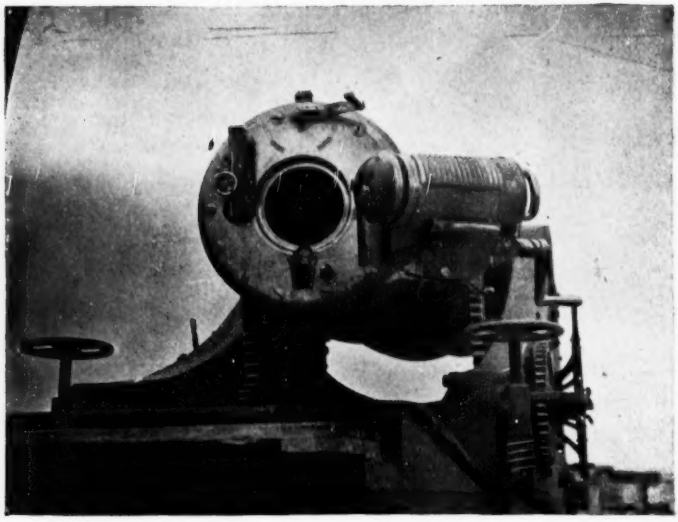
As used at the Sandy Hook Proving-Grounds, the Le Boulengé chronograph consists essentially of a brass column carrying near the top two electro-magnets of which the poles are pointed similar to the smaller end of an egg; the currents which actuate these magnets pass through two screens of copper wire placed one hundred feet apart in front of the gun to be fired, the first one being about fifty feet from the muzzle. These velocity frames consist simply of square wooden sashes over which copper wire is passed up and down like the wires of a gridiron, and which are intended to be cut by the flying shot and so to break the circuit of the magnet and demagnetize the cores, thus letting fall the recording armatures which have previously been suspended from their poles. On the magnet to the left hand of the instrument is suspended the recording armature which in falling strikes the trigger of a knife, releasing it and making an indent on the falling chronograph.

Now let us suppose the instrument set up, the gun loaded and the velocity frames connected in the circuit. At a signal from the gunner, the lieutenant at the instrument closes the circuit through the magnets and carefully suspends the two armatures from their poles. Immediately he throws a switch which simultaneously opens both circuits and allows both of the armatures to fall, recording thus on the chronograph the mark, as it is called, of "disjunction" or of simultaneous release, thus eliminating the lag of the action of the whole mechanism, magnets, trigger and knives as well as the breakage of the current, and with this point of reference thus established he is ready for the firing, the circuit is closed, the armatures again suspended, and the signal given. At the report of the



3.6-INCH FIELD GUN MOUNTED FOR POWDER-PROVING.

[With Velocity Frames in position and butt for catching shot in the background. Butts at 2000 and 3000 yards shown to the right in the distance.]



OPEN BREECH OF EIGHT-INCH STEEL RIFLE, SHOWING TWO PRESSURE PLUGS IN POSITION IN MUSHROOM HEAD OF BREECH BLOCK.

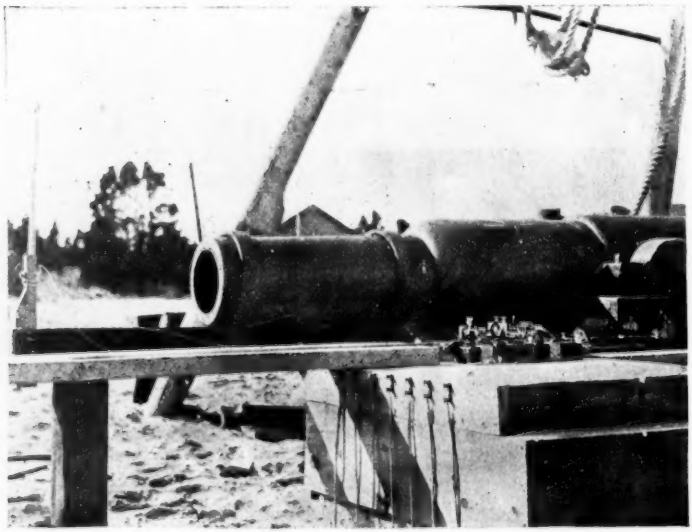
gun the armatures fall again, but this time the long chronograph has dropped at the cutting of the first screen and is falling when the shot cuts the second screen releasing the recorder and making a second indent from the knife on the chronograph near its upper end, the distance of which from the disjunction mark gives by the law of a falling body the time of the passage of the shot across the hundred feet between the screens. Difficult as is this problem of determining the velocity of a shot in its path, it is simply and accurately solved in comparison with the accompanying phenomenon, which must also be studied to determine the safe allowable speed of the shot.

Pressures in the gun should be determined also or the gunner will endanger his own life in piercing his enemy's armor, and as these pressures vary from twenty to fifty thousand pounds per square inch, and are delivered almost as a blow at the firing of the charge, the difficulty may be imagined. Rumford, to whom the original solution of many of these problems is due, investigated the action of the powders apart from the gun by exploding them in a small chamber fitted with a piston on which he could pile weights to be raised by the discharge, but charges of twenty-five or

GENERAL VIEW OF BATTERY SHOWING TEN-INCH STEEL MORTAR AND TWELVE-INCH CAST-IRON BREECH-LOADING RIFLE AT CENTER.

[Piles of shot to the left; bomb-proof shelters to rear of guns.]

thirty grains under conditions far different from the actual in a gun, were all that he was able to control. Complete combustion also took place in his small charge, whereas there is always a certain amount of yet blazing powder blown from the muzzle of a gun at the discharge. To study the actual occurrences along the bore was the aim, and at last the "Columbiad," a gun famous in the sea fights of 1812, was designed from the results of the experiments of Colonel Bomford, who placed small bullets in holes bored along the length of a cannon at right angles to its axis, and from the velocity with which they were ejected calculated the pressure. With the outbreak of our Civil War many of these problems which had thus received theoretical consideration came to be practically tested, and many changes in ordnance were made from the results of actual disasters of the field, and so the Dahlgren gun was constructed and remained the highest evolution of field work, until Captain Rodman came to make his experiments and design the famous cast-iron gun which bears his name.



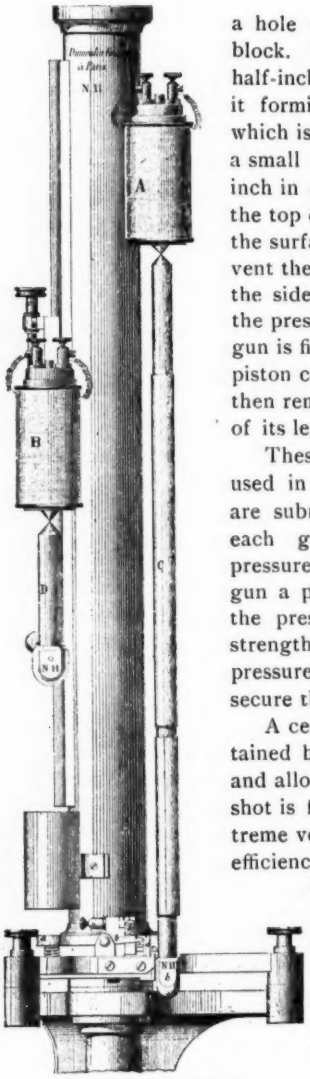
SEVEN-INCH STEEL HOWITZER MOUNTED ON FREE-RECOIL CARRIAGE, WITH SIEBERT VELOCIMETER ATTACHED TO STONE PILLAR IN FOREGROUND.

(Ribbon of velocimeter, shown on plank to the left, attached to gun trunnion at right of picture and contact for recording emergence of shot from muzzle shown at extreme left.)

SHELLS AND POWDER-CHARGES READY FOR LOADING INTO GUNS.

Pressures being one of the most important points which he wished to determine, he devised for the purpose the gage which for many years held the first place; on a secure backing within a hole bored in the gun, a copper disk was placed, and resting lightly on it a knife with a circular blade attached to a piston, whose upper surface was open to the powder chamber. When the gun was discharged the pressure on the piston forced the knife into the copper and by the length of the cut determined the pressure, by comparison with similar cuts made under a hydraulic press where the power applied could be accurately measured. This very ingenious and simple method was used for a number of years giving satisfactory results, but many accidents occurred to the knife edges and a considerable error was easily introduced by the difficulty in determining where the oval cut really vanished. Accordingly, when Captain Noble, of the English Ordnance, conceived the idea of simply compressing a rod of copper and measuring the decrease in length, a few experiments proved the superiority of his method and guaranteed its adoption.

The pressure-gage of to-day is a short cylinder about three inches long and one-and-one-half in diameter, which is screwed into



LE BOULANGÉ CHRONOGRAPH

[Showing rod of record C, suspended from magnet A, and the recorder D, suspended from magnet B, above the knife trigger a, b. Everything is set for firing, when the shot cuts the first screen C will drop and D at the cutting of second screen.]

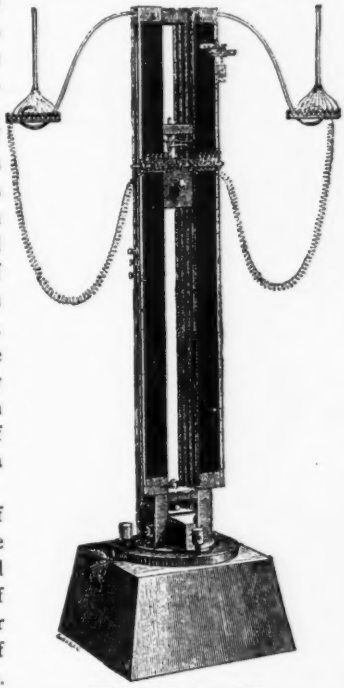
a hole bored in the center of the breech-block. This cylinder has a hole about a half-inch in diameter bored partially through it forming a chamber, on the bottom of which is placed the rod to be compressed, a small copper cylinder one-quarter of an inch in diameter and a half-inch long. On the top of this a piston is pushed down and the surface sealed with a gas check to prevent the powder gases from entering along the sides of the piston, and counteracting the pressure on its upper surface. When the gun is fired, the pressure of the gases on the piston compresses this small copper which is then removed, and by a simple measurement of its length the pressure is determined.

These two instruments are principally used in proving the different powders that are submitted for use in the different guns, each gun being designed for a certain pressure and velocity of shot, and for each gun a powder must be secured with which the pressure will not exceed the working strength of the gun, and with which that pressure will be so long continued as to secure the desired velocity for the shot.

A certain efficiency of the powder is obtained by lengthening the bore of the gun and allowing the powder to expand as the shot is forced forward, but the need of extreme velocities is supplied by sacrificing the efficiency and making the powder slower and slower in burning, so that a very great pressure is not produced, but the maximum pressure is continued for as long a time as possible, and to further examine the powder in this particular, an instrument called the Drop Chronograph is used.

In this instrument there are two iron standards at the sides and

falling as freely as possible between them a square block of iron weighing about thirty pounds, carrying on the side of one standard a tuning-fork making about thirty-five hundred vibrations per second, and on the other several electro-magnetic styluses. The two standards are covered with lamp-black, and as the weight falls a wavy line is traced by the tuning-fork and straight lines by the styluses. Now when the gun is loaded ready for firing, the signal is given and the same trigger which releases the weight, also by an electric primer, fires the gun. When the charge is sufficiently ignited to move the shot, a circuit is broken and one of the styluses is moved out of its straight line; another circuit is broken and a stylus moved when the shot leaves the muzzle, and still others record the instant of the shot passing screens, which are placed as usual in front of it. Thus with the pressure-gage we have a still more complete history of the shot in its flight, and even the almost incredible record of the time it takes to ignite a charge of gunpowder.



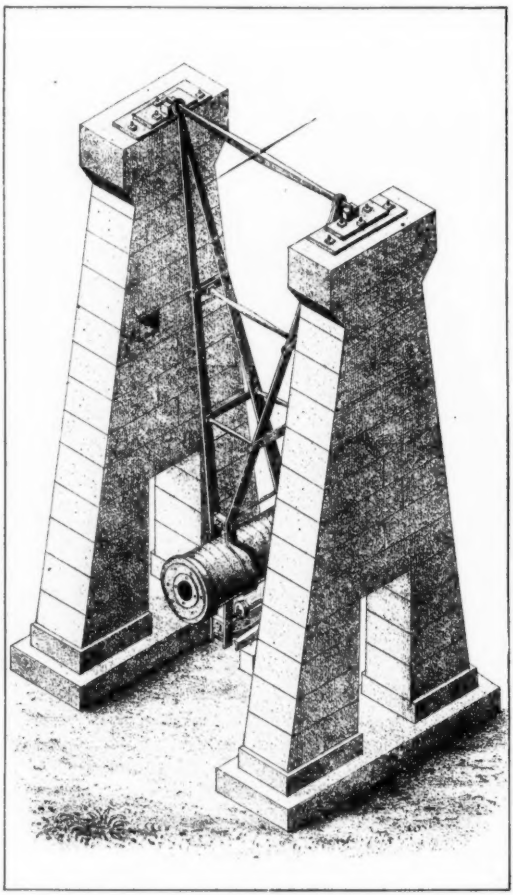
THE DROP CHRONOGRAPH.

[Showing the trigger at the top of right hand standard and the weight in descent carrying its styluses over the blackened standards.]

But as ingenious as are all of these instruments, they are checked in their accuracy and excelled in the completeness of their records by the velocimeter invented by M. Sebert, Chief of the French Ordnance Corps. The pressure-gages of Rodman and Noble and the ballistic pendulum of Robins, Rumford and Mordecai record but the maximum pressures offered in the guns, while the chronograph of Le Boulengé and the drop-chronograph record but the velocities of the shot at stated periods in its path, while the Sebert recoil velocimeter aims to obtain complete records of each of these phenomena.

In place of suspending his gun on delicate knife-edges, he

mounts it, however heavy, on rollers resting on a plain straight carriage, in front and inflexibly connected with it at the trunnion or some equally convenient point by a short stiff wire is a long steel



MORDECAI'S 10,000-POUND BALLISTIC PENDULUM AS ERECTED AT WASHINGTON.

ribbon, the surface of which is covered with lamp-black, while secured to a stone pier above the ribbon is the instrument carrying a tuning-fork, so held that a point attached to one arm may touch the ribbon. At the side of the tuning-fork are several recording sty-

luses attached to electro-magnets. When now the gun is fired and commences to recoil, the steel ribbon is drawn backwards under the tuning-fork and the styluses, the beginning of recoil being at the moment of the movement of the shot. The trace of the tuning-fork in place of being a straight line repeated over and over again, is drawn out into a widening wave, and as the gun goes faster and faster, the thousandth of seconds which the fork is beating are widened till as the shot leaves the muzzle, a record is made by one of the styluses which the others also make as the shot breaks the several screens in circuit with each of them, so recording the movement of the shot within the gun by the velocity of recoil, and after it passes out by the usual method of timing its passages over measured spaces.

The weight of the gun is known, as is also the weight of the shot. We have on the blackened surface of the steel ribbon traces of the thousandths of a second determining the velocity of the recoil, and by a simple calculation the pressure of powder necessary to move at this speed such a mass is easily obtained. Also since the same energy is exerted upon both shot and gun, the velocity of the shot at every thousandth of a second in its movements within the gun is determined.

This ingenious instrument has established in the hands of one of our Ordnance officers several facts before suspected, namely, that in all probability the Noble pressure-gage, by reason of the elasticity of the copper, recovers from the pressure to which it is subjected, and indicates too low a figure; that the shot arrives at its maximum velocity after it leaves the muzzle of the gun, and that certain recently manufactured powders while producing a very low maximum of pressure, are capable of sustaining it for such a time as to drive the shot at a much greater velocity than the more dangerous pressures produced by the ordinary powders.

One naturally exclaims in closing such a chapter of human endeavor and ingenuity, *Cui bono?* Is it for the destruction of our fellows to whom we have never done wrong, and whose faces we shall never see, that we are devoting all this scientific attainment and ingenuity? To this the army man replies, whatever the naval engineer may say: "We are perfecting the irresistible armament with which it would be certain death to combat, and which is forever rendering war an impossibility." It seems true, this anomaly, and if they are thus perfecting eternal peace, this work upon the guns is for humanity and a part of the race development.

THE RAILROADS AND WALL STREET.

By Thomas L. Greene.

ONE of the most noteworthy features of modern commerce is the rise and growth of great corporations, particularly in transportation, though we find important examples of the same tendency among other industries. The large corporation requires a large aggregation of capital to be furnished, generally speaking, by many investors who supply the necessary funds in small amounts. The capital of our great undertakings therefore comes from the savings of the people, for the investments of the public form the backbone of our modern methods of trading and manufacturing through combination.

Because of these conditions there has arisen a class of men whose business it is to bring the investors' money to the corporation and to carry opportunities for the investment of his savings to the small capitalist. The common name for these middlemen between need and supply is that of bankers. This, however, is inexact, because the American definition of a banker is one who receives the money of others on deposit and loans it out on good security. The promoters in question, however, undertake to "finance" enterprises; that is agree to furnish money at least for the beginning of the new business, trusting to their facilities and reputation to sell to their customers the evidences of debt (*i. e.*, bonds) or of partnership (*i. e.*, shares of stock) thus acquired from the newly-formed corporation.

So necessary is the promoting thus described and so strong have the houses in this line of finance become, that it is practically no longer possible for the originators of a new business of any magnitude to get the necessary capital in any other way than by applying to the class in question. It is cheaper to pay these bankers the price they ask for their services than to attempt to gather together the required money by appeals to the investors directly. In addition to these financing firms there are others, usually known as brokers, who have their own following of small capitalists throughout the country. These city or country friends who have money to invest ask the brokers' advice and buy stocks and bonds through them paying them one-eighth of one per cent. on the sales as a commission.

In this way the bonds and shares of the railroad or industrial corporation are distributed throughout the country and money is gathered to repay the financing firm for its advances to the originators and managers of the enterprise. "Wall Street" is the general name given to that section of New York having Wall street proper as a center, where these various financial operations are carried on, the name also being often applied to the affairs themselves.

Money cannot be borrowed in Wall street for new undertakings without, first, a very thorough investigation into the conditions under which the enterprise is started and the prospects of success. If this is satisfactory the next step is the question of terms. Promoting houses do not lend money, like banks, at a specified rate of interest expecting to get back only the amount loaned. The risk of loss; the advantage of a following of small investing capitalists; the importance, often great to the originators, of money to begin operations at once or perhaps to save works already half built from foreclosure;—all these entitle the financing firms to a profit much greater than can be exacted by banks which lend money on approved collateral. From those exacted profits has come much of the common talk about "Wall-street sharks"; epithets whose makers lose sight of the fact that money in the Wall-street sense is a commodity to be had, if had at all, by those asking for it at rates fixed by the same laws which determine the prices of silks or sugar. Money is plenty enough in ordinary times to those who can show a business right to ask for it; those whose claim to financial help is of doubtful character must pay for that help in inverse proportion to the probability of success. The corporate form of conducting business has greatly assisted this process. The capitalization of a corporation represented by bonds and stocks can easily be divided into small lots so that those whose savings are not large can still hold one or more bonds or several shares of stock. The purchasers acquire a specific percentage of the total valuation, and thus a corporation whose capitalization in the aggregate is enormous may find its ownership made up of a multitude of men whose individual holdings are insignificant.

The prices charged for their services as middlemen by the bankers vary greatly according to the conditions of the money market and the circumstances attending the enterprise. The financing firms compete with each other, as houses in other lines of business do, though they often act in concert where their common interests are at stake or where syndicates must be formed to carry

through undertakings requiring more money than any one firm can easily furnish. When an old and well-known railroad, whose credit stands high with investors, wishing to build an extension or improve its terminals, offers to place the entire issue of new bonds with some one financing house, there is always competition to secure such issue. Bids are made at the lowest price ; 5 per cent. would be exceptionally high in such a case, 2½ per cent. being more frequent. In ordinary markets and for roads whose prosperity is good though not of world-wide reputation, the usual price of promoters for placing the bonds is 5 per cent. or 10 per cent. if the sale is guaranteed. From the smallest percentage the charges range upward. In enterprises unknown to the public whose success must be accepted as probable by investors because the banker recommends it, the financing house usually arranges to participate in the expected profits. Besides taking the bonds at a discount the banker often insists on a certain proportion of second or income bonds or of stock as a "bonus."

In the case of new railways it is customary to build the road almost entirely from the proceeds of an issue of bonds. In such cases the stock represents the control of the road and also the equity of the originators and promoters in the future profit of the enterprise. This stock may be divided in agreed proportion between the two parties. Then the railroad being built by the bonds is worth at first perhaps not more than its cost. The combined experience of these parties we will say is justified by the result ; so before long it becomes clear that the earning power of the new railroad is much greater than the fixed charges ; *i. e.*, than the interest on the bonds already sold to investors, the taxes, rentals and all other similar charges. After setting aside something from earnings—as every new railroad should—for improvements to property, in time it comes about that dividends can fairly be paid upon the stock which, as we have seen, originally represented no cash outlay. When this time comes the bonds in the open market are strengthened by the fact that dividends are being earned, while the quotations for the stock are slowly going up from next to nothing toward par. As it is not the business of the bankers to keep their money long invested, they always take advantage of such a rise in prices to sell out bonds (if any left) and stocks to the public, and thus prepare to use their capital in floating other enterprises. It is true that this process involves selling to the public as genuine investments stocks which once were worthless and cost the promo-

ters nothing, but nevertheless it is perfectly fair to the public provided the facts are understood and the final prosperity is as represented. The bankers sell that which at time of sale has value; the difference between that value and the value at the first building of the road constitutes a fair profit to those whose money was risked (for many new roads have to go through bankruptcy before success) and whose long training and business sagacity alone enables them to distinguish good schemes from bad;—for bad plans are offered continuously and in plenty to Wall-street houses.

The mistake often made is to suppose that Wall-street bankers alone furnish all the money for corporate undertakings. Bankers of course have large capital of their own which they advance, but their reliance in the end must be upon the investors of the whole country. The moment signs appear that from any cause the capitalists of the country are getting less confident and more chary of purchasing, that moment financing houses begin to curtail operations. Plans which once would have appealed to them are rejected without much examination. Only the most approved enterprises are considered at all, such as are sure to find purchasers for their bonds, no matter how investors may neglect less-known issues. Banking houses of the most unquestioned soundness after the Baring troubles, found their capital locked up in the bonds and stocks of enterprises which became slow of sale. The process of getting these issues off their hands by slow degrees has gone on for more than a year, no new railroad meanwhile standing much chance of getting the required capital. Even in the case of old and good roads, tests put to the investing public showed a decided disinclination to purchase such good bonds for large amounts except at sacrifices which the managers of those railroads were not willing to make. Hence we find universally the growth in railroad reports of floating debts, meaning money borrowed on the deposit of the unsalable bonds to an amount so much in excess of the amount loaned, as to put the security of the debt beyond question. When the investing public again buys bonds freely, these hypothecated issues will be sold and the borrowed money repaid, the company saving the difference in principal between the face of its debt and the face of its hypothecated bonds. This difficulty in selling bonds or in borrowing money except under severe conditions affects immediately the number and amount of extensions or improvements contemplated by the railroad. The result is that fewer men are employed, less material bought, less steel and iron pur-

chased. This decrease seems to us unnatural, because the country generally advances so rapidly in wealth that all our estimates of values are based upon the future; so that we are inclined to consider a normal volume of traffic or of business as constituting actual depression.

So far only the railroad and the investor have been considered; for these, with the necessary middlemen, form the mainstay for all large financial operations. But a very important influence upon the general market is exerted by the speculator. Those who make a business of buying and selling bonds and stocks frequently in the markets, according as conditions lead them, have their place to fill in our financial economy because they base their trading upon the laws of the human mind, quite as much as upon the trade laws of demand and supply. There is a misconception among certain classes of our citizens (notably among the farmers) as to the part which speculation plays in fixing values. It is supposed for example that "short" sales of stocks or produce (that is, sales of articles which the seller does not then own) are mainly responsible for any decline in market quotations. It is rather the province of speculation on the whole to serve as a balancing-pole; to keep fluctuations in prices from going too wide of the line of actual values either way. The frequent buying and selling steadies the market. But because rapid advances or declines in prices mean profits or losses to the speculators, these watch for causes and signs of such changes, and acting on early information thus bring about resulting fluctuations much sooner than if the older and slower methods were employed. Speculators do not create values in the true sense, they only bring about a rapid registration of such values. Such purchases or sales are not causes of changes in quotations so much as themselves the quick effects of those causes.

The financing firms spoken of are rarely speculators; that is, they do not generally use their influence and capital to put prices up or down merely with the idea of selling out or buying in at a large profit; such practices would lose them all their followers. Nevertheless the use of speculative methods is considered legitimate within right limits. While facts in the long run must determine values, and while market quotations of any railroad bonds or stocks must in the end conform to the real prosperity and prospects of the concern, there is yet a wide stretch of time before such causes would work out their full effects if left to themselves. It is fairly within the province of the financing firm to use all right

means in hastening that result. If an enterprise, sound and with fair prospects, but not widely known, is in their hands, it is often the case that the firm will put aside a certain amount of money to "boom" the stock. They will issue orders to brokers to buy all such stock offering at advancing prices; the rising quotations are noticed first by the hand-to-mouth speculators who think that the great firm have some scheme on hand and who, wishing to swim with the tide, buy the stock and help swell the amount of sales. The attention of the whole country is soon called to the railroad in question; inquiries are made of those living near it as to its prospects; then after investigation—if the plans of the financing firm are based on sound values—very likely the stock may stay up where it has been put because holders and buyers have been convinced that the new prices are no higher than the merits of the property warrant. Then the financing house find a ready market for the bonds of this railroad which they had bought at a low price and which they could not otherwise have easily sold. Thus it will be seen that while facts must govern in the end, opinion as to those facts must be created

It is a common remark that prices in Wall street are all made through manipulation. In a sense this is true and from the nature of things must be so. Somebody well informed on the real merits of a railroad must begin buying before the general public can be expected to take any interest. That somebody must have capital enough to carry a large amount of stock before his purchases have their effect and general interest is aroused. His profits in successful cases are very great but without his aid the project must have waited years before getting any credit with the investing public.

As may be easily seen such possible manipulation may give rise to the greatest abuse. Prices may be put up without reference to values; skilful but unscrupulous men are always ready to carry out any programme which will let them "unload" worthless stocks upon the "lambs" of Wall street, the latter being the name for those who buy and sell without investigation and without having a reason for what they do; such are certain in the end to go home "shorn." Much depends upon the reputation of the underwriters for honesty and—what is equally important—for good business judgment as to the success of the undertakings taken up. It is an error, again, to consider these great banking houses as financial czars; they have great power but it is strictly limited. Their success is largely due

to their ability in discerning the signs of the times and in shaping their course accordingly. Modern business is based on credit, and credit is the belief of the investors and capitalists that certain enterprises have owing to them more than they owe, and can pay their debts when due. All the trading of these enterprises is done on assumed commercial values which must change as the conditions change—hence opinion as to their solvency may differ at different times. If every firm or corporation did business solely with its own capital there would be little or no chance for the art of finance. In the long run, as things are, the decision about these commercial values must rest with the world's investors, whose belief in the soundness of their leaders' judgment on business plans may at times be shaken. This was the case in the Baring crisis because that great firm had given the weight of its approval to unsound financial plans. From this there spread a feeling that values generally had been overrated by financing firms; so owners of money to-day will not buy the stocks or bonds of corporations whose success lies in the future, no matter how reasonable the outlook for that success may seem to be. Against such a feeling, common throughout the civilized world, the greatest financing firm can do nothing but wait till confidence again returns.

The large quantities of money lying unemployed at all financial centers are evidences of the investors' distrust. Such a state of things is not normal, and is certain to be changed sooner or later. Opinion, now over conservative, will then be convinced of the soundness of this and that undertaking and capital will gradually flow out of the banks. For signs of this returning confidence the financing firms are eagerly watching; and when such signs come, these will be ready to begin again with their old business of promoting enterprises which they believe to be intrinsically sound and which, when that soundness is generally believed in, will yield them a good profit for their capital and for their experience in picking out the right things to which to give the backing of their reputation.

PRACTICAL WORK AT A MINING SCHOOL.

By E. S. Cranson.

WHEN we consider the number and seemingly inexhaustible resources of our mines, America may be regarded as *the* mining country of the world, its mineral interests being scarcely less valuable than its commerce ; yet in his report on our Western mines, published in 1869, Commissioner Ross Browne says that experienced investors would not, at that time, pay for a mine more than two-and-one-half times its yearly profit. This low valuation was chiefly due to defects of management and the antiquated and cumbrous methods of mining in use, most of them copied from foreign modes of procedure by no means adapted to the American field. Foreign engineers were employed largely, and our young men were obliged to go to Europe for their mining education. At Freiburg alone, during one year, of its 200 students one-fourth were Americans, paying at least one-half of the fees received by the professors. Upon their return, imbued with the sectional prejudices of their schools, they brought with them foreign workmen and copied the faults of foreign engineers.

Gradually, however, the idea was developed that many vexatious delays and pecuniary losses might be saved by skilful management, and that the study of American mines and mineralogy might be accomplished by Americans with better results in their own country ; that methods of operation might be more successfully tested by men who had studied these methods in their relations to the varied mass of the earth as it is found in the United States, and that the important questions of profit and loss with their intricate complications of prices, transportations, wages, etc., might be more effectually weighed and balanced by men in touch with our own national and political characteristics.

In the meantime the way had been cleared by educators, who had begun to realize that a classical education alone could not prepare for work men who were to spend their lives in carrying out great engineering projects, in the chemical laboratory, or

> " delving hour by hour to win
> The secrets of earth's inmost heart,"

and that for these men, who were every day applying the principles

of the exact sciences, a knowledge of the profound conceptions of the calculus or the mysteries of "scarped cliff and quarried stone" were more profitable than the digging of old roots in the fields of ancient literature; that, however fine it may be to ring out classic allusions in the halls of Congress, or to quote Plutarch in an after-dinner speech, these accomplishments are of little value in laying a new thoroughfare over rugged mountain and trackless desert, or in harnessing the lightning to carry the thought of modern times.

So Harvard and Yale, in 1846 and 1847, made provision for scientific departments and other colleges followed their lead. Instruction in mining engineering was also introduced, but this department at first consisted of little more than lectures on mining and metallurgy tacked on to the regular course. The polytechnic institute at Troy had already demonstrated the value of mechanical and scientific study, and the Boston Institute of Technology, founded in 1865, has since made a high reputation in its special departments, which also include mining engineering. In 1864, Columbia College started her School of Mines, which, with the prestige of connection with one of the leading colleges in the country, has easily taken the lead among schools of this class, having graduated more than three times as many students as any other mining school in the United States. Within half-a-dozen years after its establishment it is said that even among the long-established "Bergakadamies" of Europe, no school of mines could be found in which the departments were maintained with equal care, and that with the possible exception of the mining academy at St. Petersburg none could compare with the equipments of its chemical and assaying laboratories.

These, and other scientific schools, have sent out every year men who, after some experience in actual work, have become skilled and careful engineers, assayers and mining clerks, superintendents and agents, resulting in much good to all mechanical industries and particularly to mining property, where the decrease in expenses and increase in returns have been in direct proportion to the march of scientific investigation and the greater efficiency of the officers and engineers. With the development of the country, more and more urgent were the calls for men who had made the peculiar needs of our mines their study, and more schools of this sort were demanded. It then seemed wise that these institutions should be located where a special feature might be made of practice-work in mines and mills appurtenant to them, which should

render the pupil familiar with the use of the machinery and operations connected with the processes of obtaining and treating ores.

A writer in the *North American Review* for January, 1871, in an article on "Mining Schools in the United States," predicted that in time such an institution would be demanded and established in the great mining-region of Lake Superior, that treasure-house of mineral wealth where the copper production is the greatest in the world; where millions of tons of iron ore are annually shipped; where gold, silver and nickel are found; where granite and sandstone are quarried, and where the great natural waterways, connected by that costly system of ship-canals whose commerce exceeds that of the Suez canal, largely assist in the development of those rich resources. In 1885 the State of Michigan, recognizing the imperative needs of her own mining interests, founded the Michigan Mining School at Houghton, in the Upper Peninsula. The end sought was to train its students in thorough practical knowledge of those branches of science useful in developing the mineral resources of the country. It is the only pure school of mining engineering in the United States, as all other similar institutions have other courses of study and confer other degrees. How properly to combine theory and practice long has been a problem among scientific schools which this institution has gone a long way toward solving. Not only does its scheme of study differ in many respects from that laid down by other mining schools, but, also, its practice-work is a unique and special feature, being to the candidate for engineering degrees what hospital practice is to the medical student.

Looking back over the history of educational work, one may see how great a change has been wrought within a half-century in the manner of teaching chemistry, physics, mechanics, and kindred studies. Where once a class listened to lectures and saw experiments illustrated before them by the instructor, now all well-equipped schools have their working laboratories and machine-shops where the student is called upon to follow out the processes indicated in his lessons, thus acquiring a knowledge of physical phenomena and mechanical laws which he could learn in no other way with so much precision and intelligence. He becomes familiar with the applications of the microscope, he tests the strength of materials, he determines the character and value of ores by careful analysis and assay and learns to handle the engines, heaters, gages, etc., connected with a mechanical laboratory.

In educating its students, however, the Michigan Mining School goes a step farther and, having given to them a thorough theoretical training in connection with such mechanical and laboratory practice as its excellent equipment affords, it sends them out into the field under proper guidance that they may master the details of actual work in the application of the principles of science to the extraction and utilization of the varied products of the earth. For this purpose the situation of the school gives ample opportunity. Nearly opposite the school building, across the deep trough occupied by Portage Lake, are the buildings and tram-road of the Franklin mine, while the Quincy, Atlantic and Huron mines are not far away. Stretching away to the north is that great copper arm of the Keweenaw, where may be seen some of the greatest mining fields in the world, with their stamp-mills, smelting-works and hoisting-engines, of every grade and description. Near by, too, are the sandstone and granite quarries, and the Gold Range, and the great iron country of Lake Superior is within easy reach. Our embryo engineer breathes in a mining atmosphere; he hears daily discussed the topics of "adits," "stopes" and "levels" by men whose lives are spent in mining operations, and every phase of his profession may be studied in connection with his school work.

The student of the first year makes frequent excursions under a careful instructor to the mines and mills of the vicinity, studying points brought up in his class-room. The second year's men are required to put such knowledge as they have already gained into practice by underground surveying and by actual work in the mines, taking part with the miners in drilling, blasting and such other work as is practised in the different mines. The third-year class take up more difficult subjects in mining, hydraulic, electrical and mechanical engineering, assaying, ore-dressing, etc., in which the members have constant practice and opportunity for observation in mines of every grade, from mere open pits to those that are over 4000 feet deep; the latter constituting veritable undergound cities, fitted up with every appliance which modern ingenuity can contrive for the saving of labor and the treatment of ores. During all this time the student takes copious notes, thus providing himself with valuable reference-books for future use.

So liberally disposed are the mine-owners of Michigan toward these young men in whom they see their future clerks, engineers and superintendents, that all these unrivaled natural advantages and the costly appliances representing the vast capital invested here,

are freely and courteously placed at the disposal of the students for purposes of practice and investigation. Thus the student imbibes a mining spirit; all his associations are in conformity with his schooling and he can study the defects and advantages of different methods for future utility and can see his experiments verified in every-day operations around him.

Another special and valuable feature of this school is its summer-term work, which is purposely arranged so that students of other schools may take advantage of this vacation practice as, also, persons unable to take a complete course—being open to all who desire to attend. Plane, topographical and railroad surveying is given in connection with the first year's work, in the summer, beginning about the first of July. Special students are required to prepare themselves in the first two books of Davies's Surveying, and the course is made thoroughly practical, the distinctive work of the school being carried out by the re-survey and correction of mining-claims.

In the second year students have six weeks work in mining and mining-surveying, visiting for that purpose the iron country about Gogebic, surveying some mines and taking notes in others. This work, coming in the spring and requiring special preparation, is not easily taken by others than the students of the school. The summer term of this year is spent in shop-work, provision being made for any person desirous of improving his knowledge of practical work with machinery. The summer term of the third year is spent in the study of questions in economic geology, petrography and mineralogy, striving to make the student fully understand the "testimony of the rocks" and, to guard against the disastrous mistakes often made by men of much engineering and metallurgical skill from ignorance of the nature of ore deposits, this subject receives special attention. This class is under the guidance of the Director himself. Teachers will find this course of great value in this region where nearly every problem in geology is presented for solution, and it would prove a delightful summer outing to any persons interested in geological subjects, and desiring to collect specimens. In 1890 the class studied the Lake Superior coast and adjacent islands north and south of Marquette and the country about Negaunee, Ishpeming and the Gold Range.

Arrangements have been made with the University of Michigan whereby students in the engineering course of that institution may take this summer course at the Mining School, obtaining credit

therefor on their regular course. The same might be done by students of other schools who desire to utilize their vacations and obtain this special practice in connection with their regular studies. The location of the State Geological Survey at Houghton is of incalculable benefit both to the school and to the survey, resulting to their mutual advantage in many ways. This is largely due to the fact that the Director of the school is also the State Geologist and his assistants are more or less connected with the school. The Survey is also in harmonious coöperation with the United States Coast and Geological Surveys, all thus conspiring to bring the students of the school into contact with the practical applications of geology and the discussion of its more important problems, which assists in their training for intelligent exploration and brings them into relations with men of science everywhere. The collections of the Survey are placed at the convenience of the school, and the libraries and laboratories of the school are freely used by the Survey. The geological work of the summer is made more valuable for the students by following the ground previously gone over by the Survey, observing the methods pursued by that organization. Dr. M. E. Wadsworth, the Director of the school, is a graduate of Harvard and Bowdoin colleges, a fellow of the Geological Society of London, the American Geological Society and Society of Naturalists, etc. He has had nearly thirty years experience in educational work, has taught in Harvard College, worked with Agassiz and Professor Whitney, and is the author of many works on educational subjects.

The difficult task of organizing this new school with its peculiar work, in a new country where educational spirit had not yet reached the high-water mark, was intrusted to Albert Williams, Jr., a graduate of the College of New Jersey and Columbia School of Mines, and well-known in the scientific world from his connection with the United States Geological Survey and his contributions to the technical literature of the times. He had associated with him two instructors, men of scientific attainments and practical experience in their professions and was assisted by a Board of Control, consisting of men of education and energy residing in the Upper Peninsula and devoted to the interests of the school. The first year opened with seven students, which had increased to twenty-three at the end of the school-year, at which time Mr. Williams resigned to take up other duties.

In the meantime, ground for a building-site had been donated

by the Hon. Jay A. Hubbell, who has been one of the firmest and most untiring friends of the school and to whom its establishment is largely due. The Legislature of that year had made appropriation for a building-fund, but the building had not been commenced when Dr. Wadsworth entered upon the duties of his position. The school was held in cramped and inconvenient quarters in the engine-house of the village. There was no equipment adequate to the needs of such a school, funds were limited and a large number of the citizens of the State inimical to its interests. These first years were years of constant labor under most depressing circumstances, and only energy and ability of an exceptional sort could have overcome its difficulties.

This year there is a large corps of instructors, all men selected for their peculiar fitness in their special departments, while the school register shows seventy-four names, exceeding all others of its kind in numbers. The handsome building of Portage Entry sandstone with stamp-mill and roasting-furnace adjoining is amply equipped with the necessary appliances for its work ; it has a large and valuable library and is absolutely free to students although it has no landed interests and is entirely dependent upon the State Legislature for its needed appropriations. These are, however, becoming every year more liberal as the school demonstrates its ability to become an important factor in aiding the development of the mineral interests of the State. It has had also a number of private benefactions to aid students, etc., from men of wealth who recognized its growing usefulness.

The course of study covers three years, which, with its requirements of seven hours class-work per day, its Saturday excursions and its summer field-work gives a school year of forty-five weeks and is nearly, if not quite, equal to four years in any other institution. The curriculum is very severe and a high grade of work is required, many not being able to complete the course in the time specified but having to take one or more extra years to graduate. The fall and winter terms require strict application to study, but the summer work in this cool and salubrious region almost serves as a vacation after the constant study of the preceding terms. The young men who took the spring work in mining-surveying this year report themselves as in excellent health, notwithstanding their seven hours per day underground work in the dripping mines, often coming up wet through and plastered from head to foot with the soft, red hematite ore, and with appetites scarcely to be appeased

by the rude miners' fare provided at some of the more distant stations.

The attention of men of science everywhere has been favorably attracted toward the school and its graduates are eagerly sought for as having proved themselves able to enter at once upon the practical work of their profession without taking the time usually spent in "working in" by most young men fresh from the class-room. This makes them more valuable from the start to their employers and gives them an opportunity to rise more rapidly in their profession. When the fact is considered that good mining engineers are seldom without remunerative employment in these days when so many trades and professions are overcrowded; when, to quote from a late number of THE ENGINEERING MAGAZINE a passage which is valuable enough to bear repetition more than once: "Theory without practice is absolutely a worthless commodity; practice without theory is worth about fifteen dollars a week, and when both are well combined in one man of sound judgment the combination is worth up to ten thousand dollars a year," it would seem that the earnest young man with a bent for the exact sciences, or the anxious parents about to choose where best their son may be fitted for his life-work, will do well to take into consideration the peculiar advantages offered by this free, technical school to which the people of Michigan, already noted for its great University, point with so much pride.

IMPENDING DISASTER ON THE MISSISSIPPI.

By a Southern Engineer.

THE imagination almost fails to grasp the vast expanse of water-shed drained through the lower Mississippi river. From the Alleghany Mountains, back of Pittsburgh, to the sources of the Missouri river among the Rocky Mountains is a distance in a direct line of more than two thousand miles. From the head waters of the Mississippi itself, near the Canadian frontier, to the Gulf of Mexico is another stretch of about equal extent; and discharging their waters either directly or indirectly into the main channel are more than a half-dozen rivers that would be measured among the great rivers of the world were they not merely the fountains of the stream that, by a curious inversion of the paternal idea, is sometimes called the Father of Waters. Add together the length of the Yellowstone and Missouri rivers, the Ohio, Tennessee, and Cumberland rivers, the Arkansas river, and the Red river, and we have a total length, approximately, of eight thousand miles. Were we to include the upper and lower Mississippi in the calculation, together with such streams as the Illinois, Allegheny, and Monongahela rivers, and the numerous smaller rivers and creeks that help to drain the contributing territory, a total of twenty thousand miles might be an underestimate of the length of watercourse in the Mississippi basin. The total area drained is estimated at 1,240,039 square miles.

It is very well known, however, that the quantity of water that passes between the levees of the lower Mississippi is exceedingly variable and inconstant. From an almost sluggish stream at times it becomes a very hell of surging waters in only a few brief hours, threatening the security of everything not founded upon a hill. The writer has seen even a tributary river, the Tennessee at Chattanooga, rise fifty feet in a short time; and with this exhibition in memory, it is easy to realize what a tremendous volume of water may be poured into the lower Mississippi when a season of general rains has swollen all its tributaries to the point of overflow and danger. It is a sea, the contribution of many rivers, that goes surging along towards the Gulf of Mexico when the floods are most dangerous and destructive.

The theory upon which nearly one hundred millions of dollars

have now been expended in improving the lower Mississippi, is that of building levees on either bank at all points of danger, by means of which the mighty stream is forced to keep to its channel. All the modern innovations except the double dike for rendering these dikes effective have also been applied, and in some instances with seemingly excellent results. Thus the celebrated Eads jetties at the mouth of the river, which in one sense may be called an evolution of the dike system, have taught the engineers how, by narrowing the width, the body of the stream may be trained to scour a deep channel where before a shallow and broad one existed. But such an expedient on a naturally sluggish stream like the Mississippi could not be effective except where the daily reflux of the tides causes a greatly accelerated current, and in the main the dikes, built higher and stronger with each overflow, are the only protection against the floods.

Theoretically, and even without any reference to experience, it should be seen that building dikes along the shores of frequently swollen rivers must result in raising the bed over which the water flows. Sediment in great quantities is torn from the banks and carried downward by the flood ; and though the great bulk of this sediment is held in solution until it is deposited in shoals off the mouth of the stream, or even carried hundreds of miles out to sea, a still great residuum, mingled with rocks, stones and coarse gravel or sand, is precipitated to the bottom of the channel, and there, when the current is permitted to lose its scouring force through the elevation of its banks, it becomes incorporated with the soil and helps to raise it above its former level. Indeed, so manifest is this process, that it may be said that the construction of levees is only carting material to the shore in order that the river may devour and assimilate it on the first occasion when the water mounts to the level of the new barrier.

But we are not dependent upon theories when we wish to consider the subject of levees. We have been furnished some excellent examples of the results of dike building on other continents ; and it should be fortunate for the people who are to inhabit the lower valley of the Mississippi in future years that China has already been so far opened to observation that we are enabled to observe the consequences of such primitive engineering. Nearer home than China we have long had an example. The Po river, in Italy, has been elevated by dikes century after century until it now flows along the summit of a ridge, its very bottom higher than the

surface of the adjacent country, and along this river very disastrous breaks are frequent. But we now know that similar conditions have been created for the Yellow river in China, and that the loss of a hundred thousand lives during a single flood is the not unusual result. Yet the Po would rank among the smaller of the Mississippi feeders, and even the Yellow river is only a moderately great stream by comparison.

Dike building, as a means of protection against floods, is rudimentary engineering. There is good reason to suspect, indeed, that originally, it was the expedient of a savage. It is a work that calls in play none of those complex ideas that indicate a developing civilization. Nevertheless, there is a system of diking in use on some of the German rivers that seems at first thought to offer an expedient that will make such barriers permanently effective. This is the double dike. One dike is extended immediately along the river, and a parallel dike is located some distance inland, thus leaving a space of definite extent between the two barriers which may be used for pasturage during the seasons when the flow of the current is normal. When danger threatens, the flocks may be removed, and if the first dike is swept away the second will still confine the water to the space prepared for its reception.

But even this expedient can hardly be approved. In the first place the German rivers are rivulets compared with our Mississippi, or even with the Yellow river ; and Germany is yet too young in history to offer a conclusive or trustworthy example. It is only a few hundred years since the Germans were little better than nomads, indifferent to their dwelling places, and ready to seek the hill-tops if the valleys became uninhabitable. There are no dikes in Germany that have been growing for a thousand years, none probably that have been growing for nearly half that period, and there are no rivers in the country that would be very formidable until lifted to half the elevation of the dam at Johnstown. But the conditions might be made that would enable the Mississippi to deluge a country as large as all Germany in a few hours. Then, again, there is a question of drainage to consider. Except in countries that must depend upon artificial means of irrigation, rivers should be made the receptacle rather than the source of surplus water. They should not be made the fountain of stagnant, malarial pools, something which they will certainly become when their surface is elevated above the level of the adjacent country.

Let us have this subject clear. Any kind of engineering that elevates the bed of a river is only preparing difficulties that will increase in a tenfold ratio as the process proceeds. As the bed rises the current is continually retarded, and the deposit of sediment on the bottom becomes greater year by year until, finally, in the course of a sufficient number of centuries the so-called channel will represent rather a stagnant basin than a channel, and the water will be forced to flow over the summit of the dikes as the point of least resistance. For example, there is a fall of only three hundred feet between Cairo, at the mouth of the Ohio river, and the Gulf of Mexico. Then what would be the consequences at the end of a few centuries were we to follow the process of dike building until the bed of the river at the gulf has been raised to nearly the level of the bed at the mouth of the Ohio? They are easily anticipated. Were there a sufficient barrier of hills to the southward to confine the water there would simply be a new lake formed covering large parts of the States of Indiana, Illinois, Missouri, Kentucky, Tennessee, and Arkansas. But as no such barrier to the southward exists, the river would long before it reached the supposed elevation simply dash away its levees and make new channels to the gulf to the right and left of the obstructing ridge along which it had been trained to flow. The new channels would be small in the beginning and even more troublesome than the old channel. Posterity would simply have to begin all over and build two new ridges to carry off the surplus water.

This supposition may be thought exaggerated; but it only represents an ultimate possibility which we are continually illustrating in degree. Then let us consider the true remedy. It will be necessary in part here to speak theoretically again, for except the fact that single dikes are to the last degree mischievous, and double dikes only of doubtful and temporary utility, it may be claimed that nothing can be regarded as completely demonstrated. There is no broad historical or current enterprise that may be used illustratively. But it seems, theoretically, and we are not absolutely without facts to reinforce the opinion, that the true solution of the Mississippi problem can only be found in opening new channels to the Gulf of Mexico, and in straightening the bed of the stream. We must permit the current to divide where the river is most tortuous and obstructed, and we must reform some of those erratic bends that compel a steamer to go twenty miles in order to cover a single mile in the direction of her objective point.

Considering the topography of Louisiana and her bayous with their connecting channels on the west side of the Mississippi and the proximity of Lakes Borgne and Pontchartrain on the east side, it ought not to be very difficult or very expensive to convert nearly all the district south of the Mississippi line into a delta. The waters themselves would do the chief part of the work when the connecting channels were once well opened; and after it was done, and some of the obstructing bends, like the great one opposite Vicksburg, cut away, the channel could carry harmlessly to the Gulf a larger volume of water than it will ever be compelled to carry.

As to the district above Vicksburg, sometimes flooded, the increased rapidity of the current would almost certainly keep the waters below the danger line even during the most threatening floods. Or, even if it did not accomplish so much, it would so far relieve the pressure on the levees that but little labor would be required to keep them in repair until the day finally came when the scouring of the river would so lower the bed that no levees would be necessary at any point.

The first objection that will be made to this plan is almost self-evident. The obstructing bends in the river retard the current and make the stream more navigable. Remove the obstructions and create a delta to facilitate the flow of water and the river might become unnavigable. But there is slight danger. A fall of three hundred feet in a thousand miles is only a little more than three-and-a-half inches to the mile, and the Niagara river is navigable, sometimes even for vessels under sail, where it falls five feet in three miles. But even if the river were made unnavigable, which is not possible, would the disaster be as great as the disasters that sometimes occur in the valley of the Yellow river? The day has passed when waterways can be considered as the foundation or even a strong support for commercial prosperity. At best they are but auxiliary means of trans-continental communication. Already the Mississippi has been paralleled by one railway, and will be paralleled by another and still another as fast as their construction can be promoted by enterprise and profit. The money that has been sunk in levees on the lower Mississippi would build two railways from Cairo to New Orleans. To say nothing of State and private expenditures, almost one-sixth the total of all Congressional appropriations for the improvement of rivers and harbors has gone into the dikes, and the inevitable has followed. The river is more dan-

gerous to-day than it has been at any other period since the days of De Soto.

There could be no force in objections made against the suggested plan of improvement in behalf of navigation; but there would be still another objection. Citizens of New Orleans might shudder at the idea of new channels to the gulf opening to the northward of their city. One channel at least would be more direct than the existing channel; and they might fear that it could become the main channel and leave them commercially stranded. But this would be a danger too remote to be worth considering. With railways still coming from the North, East, and West it ought not to be difficult to make New Orleans quite independent of any main channel of the Mississippi. For the future of the city, if the work of dike building is to be continued, the river is much more threatening than promising.

No valid objection can be raised to the proposed plan, and it only concerns us to know if it would be effectual. No great river has ever received such treatment, and questions of practicability will be raised. Would the opening of new channels and the straightening of the bed so accelerate the flow of water that there would no longer be danger from floods? It could be urged that an affirmative answer to this question could rest only upon theory. But it is a theory that may be easily demonstrated. In fact it is a theory continually demonstrated by every farmer who has low-lying lands that must be drained by artificial means. When one ditch proves insufficient for carrying off the surplus water he either enlarges the ditch already dug, or he digs another, which amounts to the same thing. He never thinks of accomplishing his work by diking the sides of his ditch and training the surplus water to follow its old course in greater depth. But it is also a theory which may be demonstrated by any man who is abroad after a copious shower, and finds the waters of numerous small rivulets forcing their way turbulently past obstructions in their rush down the hillside in search of the larger brook. He will see in these rivulets a perfect representation in miniature of the larger river; and let him remove the obstructions in any selected rivulet, straighten the channel, open a new mouth or two with his walking-stick near the place of discharge, and then observe the effect of his work on the current. He will never afterward be heard to say that the proposed treatment for the lower Mississippi would not be at once both simple and effective.

The living generation and the generations immediately following will have great responsibilities in their treatment of this stalwart river, for it will not do to say that if the practice of building dikes proves ineffectual the true remedy may be applied at a later period. We know absolutely that the practice will prove ineffectual. This much we have already demonstrated in our own experience even had we not the experience of twenty centuries to aid us in reaching conclusions; and every foot added to the elevation of the bed of the Mississippi river will be a measure of peril and perplexity for future generations. The time to apply the remedy is before much mischief has been done. It is not worth while for a man to break his leg because he knows absolutely that the doctor is skilful at setting bones.

In appealing to the whole country for money to meet the cost of improvement on the lower Mississippi the people of the endangered district should bear in mind that their appeal is like an appeal to posterity. The whole country cannot sensibly consider makeshifts, merely temporary expedients adopted for the security of the moment. If that is all that is required the labor and the cost belongs properly to the people who are to be benefited; and there should be no more Congressional appropriations for dike building. But the whole country can very properly be asked to help in providing for the security of future generations; and a favorable response will be given with the greater alacrity when men reflect that even the immediate cost of the true remedy will in all probability be very much less than the cost of the false remedy.

PRACTICAL HINTS ON HEATING—I.

By Leicester Allen, A. B., M. E.

THE editors of this magazine have been pleased to say to me that the general favor with which my articles on "Heating and Ventilating Homes" have been received, has induced them to request me to write the present series of "Practical Hints," these being designed to be of such value as I can make them to owners, architects, designers of heating apparatus and contractors who undertake to erect such apparatus either from their own designs or from plans and specifications furnished to them. Though what I write for either of the classes named may be applicable in some particulars to the others, I shall, as far as practicable, keep them distinct, beginning with the owner. To the owner then I now address myself.

You are contemplating the erection of a house in which you intend to live with your family as a future home, and so far as your means will permit, you are naturally desirous to make this house a perfect home. A multitude of considerations crowd upon you. There is the wife who, while you have been earning, has been economizing. The new house must make her future burden as light as it is possible to make it; nothing of convenience to her must be omitted, and her taste also must be regarded. There are also the children; some special provision must be made for them, and perhaps for others that are to grace the yet uncompleted family circle. Then there is your business, which, I take it, you are not yet ready to relinquish for a life of leisure. Finally and confronting you with unmistakable meaning, there is that balance at your banker's, that you can now spare from your business to purchase the long-wished-for home, a home which, to a greater or less extent, will be representative of the tastes of its intended occupants, and partake of their individuality. In this home nest that you have decided to build there will be gay gatherings of happy people; there will be quiet, peaceful hours to be spent in rest and recreation; there will be work to be done; there will be weddings, births, sick ones to be nursed, deaths, funerals. The sad side of life cannot be canceled by the architect, the artist and the builder. But these, intelligently exercising their skill, may do much toward lessening the unavoidable ills of life. They can plan, and build, and decorate in accordance with known sanitary principles.

Health, above all things else, ought to be the first and paramount consideration in the construction of this house you propose to build. To this object all other desires should be subordinated. Of course the site selected must be salubrious, but upon a perfectly healthy spot of land it is easy to rear a manufactory of disease. There are many—far too many—such houses to be found. The doctor's bills paid in this country by reason of unsanitary plumbing, unsanitary heating, bad ventilation and lack of ventilation, probably would aggregate a sum ample to cover the first cost of sanitary construction. to say nothing of the pain and suffering endured by both sick and well that such construction would save. If the hints contained herein shall help you to attain some knowledge of how to avoid defective heating apparatus and defective systems, their principal purpose will have been accomplished.

YOU have decided upon expending a certain fixed sum, and no more, in the erection of this new home, and you should know that to heat and ventilate it in accordance with sanitary principles, the appliances will, if the work be done as it ought to be done, cost you from 15 to 20 per cent. of the entire expense of a large well-constructed building, not including the architect's fees. That is to say, a house costing $20,000 to build can rarely be heated and ventilated in the best manner with an apparatus costing less than $3000. You may

heat it and ventilate it after a fashion for less money, but if you are wise, and your means will permit the outlay, you will prefer the more costly plant. If you prefer vain show to solid comfort; if to keep up appearances you are willing to risk unsanitary conditions; if your wife, instead of being the sensible woman I take her to be, prefers to spend money for grand furniture, for the neighbors to see and talk about, rather than to invest it in that which will show only in the rose-tints of her children's cheeks and in the conspicuous absence of the doctor's carriage in front of your door; and if you are weak enough to yield the point, you may elect the cheap alternative and thereafter be as intimate with your family physician as your most devoted enemy could desire. To well heat and ventilate a house costs money. The estimate of cost given above may often be even exceeded. I have named what I consider a fair average for a first-class apparatus for a large, well-built house.

IT is my intention, by and by, to have a talk with your architect. I do not advise you to interfere with him much about either the design of the house or the execution of the work. I know him to be first-rate in his profession, and so do you, or you would not have selected him. You have told him what rooms you want in the house—parlors, library, living-room, billiard-room for the boys, nursery, etc.,—and can trust him to design, arrange and proportion these much better without, than with, your help; but you may say to him that, as your desire is to have your plumbing, heating and ventilating done in the best manner, you wish him to have the co-operation of an able expert in heating and ventilation, and to consider that desire in his design from the moment he first puts pencil on paper. Of course you will pay the expert.

YOUR expert will advise you not to have too little head-room in the cellar—nine or ten feet if possible. He will tell you that numerous advantages are secured by plenty of room here, for here will be placed a large and an essential part of the heating apparatus. In the first place with plenty of head-room the pipes can all be placed overhead, and yet leave room to walk erect below them; and whether you use a system of hot-water heating or steam, the necessary pitch or incline for the pipes to secure easy circulation can be obtained only in a cellar of sufficient height. This he will tell you, as a sufficient answer, when you, thirsting for enlightenment, ask him "what's the use in having so deep a cellar?" There will be other questions you will probably ask the expert as the plans progress; for you have your share of our common human nature, and, although confiding in the skill of others, you will still want explanations. For instance, you probably will wonder at the amount of piping laid out on the cellar-plan, and for the life of you, will not be able to conjecture why the branch-pipes should not run straight from the steam or hot-water main to the riser-pipes, instead of being made to take a right angle, as it takes so much more pipe the latter way; whereupon you will be told that the object is to give the pipes a chance to spring when they are heated, and that because, if the pipes are made to take a direct course, when they are heated they will strain not only the pipes but the fittings so much that in a short time the whole job will be leaking. Thereafter, seeing that there is a good reason for every seeming peculiarity in the plans, you will question with increased diffidence, and even perhaps preface your queries with some such remark as, "I suppose, of course, it is all right, but, if you don't mind my questions, I would like to ask," etc.

OF course the question of fire-prevention is one that deeply concerns you, and you are not to be blamed if you keep a sharp eye on the workmen, and satisfy yourself that they introduce no hidden dangers. The specification, if prepared by an expert, as I assume it will be, will name minutely all these safeguards, and as these relate to distances pipes must be carried from woodwork, to the supply of tin tubes and riser-plates where pipes pass through floors or ceilings, to the sheath-

ing of beams, etc., with tin where pipes are necessarily carried close to wood-work, the places where, through neglect of workmen, danger may creep in are sometimes overlooked or closed in before they have been properly inspected. I take it that you will read the specification carefully, and seek a full explanation of any part you may not understand, and that you will scrutinize particularly the part or parts relating to protection from fire. I think you will be likely to let the contract to a good, conscientious contractor, and if so, he will take care of this matter, or at least he will neither willingly nor carelessly permit any part of the work to be slighted; but one always feels more secure to see with his own eyes that everything is safe.

I SHALL, by and by, say something to your architect on the subject of chimneys in general, and as he possibly may not like all I shall say, I would advise you to tell him that you want a chimney-flue for this heating apparatus to have a cross-section area of not less than a square foot. He is quite likely to make an objection to this, because in a design for a house chimneys, unless having small flues, are quite apt to get in the way of other things that an architect wishes to introduce. You should hold him to it however. Your expert will tell you and the architect also, that with a liberal flue there will be a liberal draft, that the entire apparatus will be likely to operate more satisfactorily, and that the combustion of fuel being more perfect with a good draft the coal-bills will not be so liberal. These coal-bills, coming every year without fail, are not to be ignored. There ought to be at least twenty of them before that excellent boiler specified by your expert needs renewal, and an annual loss of from $30 to $50 may result as the effect of a bad chimney. The architect may suggest a compromise. He may propose to give you a chimney with a flue 6 by 44 inches, a compromise I do not advise you to accept. The nearer square, or still better, round, a chimney-flue is, the more effective it is in proportion to its area. The reason is plain, if you think about it a little. The figure containing any area with least perimeter is a circle. The rectangular figure containing any area with least perimeter is a square. Now for maximum draft the gases of combustion entering at the bottom of the chimney must be kept from cooling as much as possible until they pass out into the atmosphere at the top; and the amount of cooling during their passage, everything else being the same, will vary directly as the perimeter of the cross-section of the flue. I once had to encounter a chimney-flue 6 by 40 inches. Here was an area of 240 inches—nearly twice what was needed—and having a perimeter of cross-section of 92 inches. Had it been square, its perimeter would have been a little less than 62 inches. It had, therefore, a little more than 48 per cent. more flue surface to cool the smoke than a square chimney having the same area of cross-section. It had barely sufficient power to keep the fire alive in the boiler-furnace connected with it and it had to be altered at great expense before it was of any use. I speak of chimneys, because the outer world has no idea what trouble their insufficiency and inefficiency cause the heating-engineer. Many is the time I have declined to make estimates when requested to do so, because of the incapacity of flues as determined by their size. In such cases there has usually been found some one who would undertake the job, and I have known many to come to grief that way.

Now the things I have named are such as about which the owner of a building may properly have something to say. The rest he had better leave to the expert who draws the plans and specifications. Of course the expert will on consultation with the architect, advocate a full-sized chimney, but under strong pressure, and knowing that a smaller chimney will do, he may weaken, unless you have already insisted upon the point. Besides, the heating expert is not usually consulted until the general plan, inclusive of the chimney, has been schemed out. So it will save time, trouble and argument for you to take the matter in hand at the beginning.

Now the plans are drawn and the con-

tract is to be let. Naturally you wish to pay the minimum price for a good job; your very anxiety in this matter may lead you to pursue a course whereby, instead of securing the fulfilment of your laudable wish, you shall pay a high price for a poor job. A poor job is dear at any price. You don't want to be paying, in addition to the annual coal-bill, an annual bill for needless repairs also. Better have all well and permanently done at the outset, and subject to the approval and acceptance of the expert who has drawn the plans. In the April, 1891, number of this magazine, in an article on "Heating and Ventilating Homes," I emphasized the point that it is impolitic to seek too many estimates upon a heating apparatus, and showed that a selection of two or three first-rate contractors will always secure as low an offer for the supply of materials and the execution of the work, as is consistent with a good job. To attempt getting a lower estimate by shopping around with your plans, is to offer a premium to irresponsible men, who will intend to make a profit by putting in inferior materials and scamping the job; and as you are personally incompetent to detect these "tricks of the trade" to which honorable contractors will not stoop, and your desire to get the work done too cheaply will, of course, preclude the constant supervision of an expert, you are sure to get the worst of a bad bargain. It may be a year after the apparatus is first fired up, or perhaps two years, before you discover how badly your scheme to save money has turned out. By that time, the sagging of imperfectly-supported pipes, the settling of the foundation under the boiler, the leaks caused by want of proper allowance for expansion, the handles getting loose on the valve-stems, the failure of valves to close tightly, the freezing up of some exposed pipe, imperfect drainage of radiators, and other evils that gradually show themselves in a badly erected heating plant, will have developed, or have begun to develop themselves, and you will see that the advice I have offered as to dealing only with contractors of first-rate standing is not mere idle talk.

AFTER the work is all done don't expect that with poor coal, poor attendance and general disregard of instructions the apparatus will work all right, that is to say, run itself. You may have an automatic-damper regulator, automatic water-feeder, safety-valve, overflow tank, thermostat and what-not, but there will still be one essential never named in specifications nor supplied by contractors, without which the results will fail to justify your hopes. This article, which every owner must supply either personally or in some one employed by him, is *common sense.* No great amount of skill will be required, but there are always certain things named in directions for use, that with reference to times and quantity must put some responsibility upon the judgment of the user. It may be that after a week of use, the man whom you have commissioned to run the apparatus will report to you that the grate is down. Examining the apparatus you find the grate reposing on a bed of accumulated ashes. Common sense would have taught the attendant that those ashes ought to have been removed to make the grate stand up. The instructions have probably included directions to that effect, but he failed to appreciate their importance and so a new grate will have to be purchased. A boiler or a water-heater of any kind should be seen and inspected twice a day. All the regulating devices should similarly be examined to see that they are operative. "Cleanliness is next to Godliness;" therefore you must use good clean coal, keep the water clean, keep the boiler heating-surfaces clean, keep the smok-pipe clean and keep the ash-pit clean, if you expect good work.

ELECTRICITY.

Conducted by Franklin L. Pope.

LAST summer the city government of Cleveland made an attack on the gas companies, compelling a reduction in price from $1 to 60 cents per thousand cubic feet. The controversy over this affair served to attract public attention to the subject of street-lighting, and incidentally to the question of the municipal ownership and management of electric-lighting plants. Throughout the State of Ohio public opinion at the present moment appears to be running very strongly in favor of this socialistic policy, and a considerable number of towns, with a population in some instances of even less than 1000, contemplate issuing bonds and going into the electric-lighting business. Probably there is no way to cure this craze except to let it run its course. The teachings of experience, although instructive, are very expensive. The newspapers have instilled into the public mind the notion that the electric light can be produced for almost nothing, and that electrical companies are little better than conscienceless extortionists. While many local electric-lighting companies, in Ohio and elsewhere, are by good management earning fair but by no means large dividends, we have never yet heard of a case in which the net profits could by any stretch of imagination, be termed excessive. We predict that before ten years have passed most of the municipalities owning an electric plant will be only too glad to make a present of the outfit to any party who will give a bond to maintain and operate it at reasonable charges for service. There is no known industry in which so much money can be wasted fruitlessly by municipal ignorance in so short a time as in the production and distribution of electricity.

ONE of the principal obstacles in the way of the proper and normal development of the accommodations furnished by public companies in nearly all of our cities is found in the continual recurrence of open or covert attacks by hostile legislation, at the instigation, in most cases, of private interests, taking sometimes the form of burdensome and vexatious taxes or restrictions, and at other times of competitive projects fostered for no other purpose than to be bought off by the existing companies at a round price. Much might be said in favor of the plan which has been adopted by the street-railway, telephone and gas companies in Providence, R. I., who have sought to forestall such troubles in future by agreeing to pay the city 3 per cent. of their respective gross incomes in consideration of an exclusive franchise of twenty-five years duration, which payment, under existing conditions, is said to amount to over $60,000 per annum. There has always been a remarkable amount of good sense exhibited in the administration of municipal affairs in Providence as compared with most other cities of its size, of which characteristic the present arrangement would appear to be a conspicuous instance.

AT a recent township election in Lockport, N. Y., the voting was conducted by means of an automatic voting-machine, the use of which has been legalized by a recent act of the Legislature of the State. The results are stated to have been completely successful, the vote for sixty-four different candidates on three different tickets having been declared within a few minutes after the close of the poll. There is no doubt whatever that by means of automatic machinery the purity of the ballot might be absolutely ensured and fraud rendered impossible, to say nothing of the advantage of a great saving in time and expense. The idea is by no means a new one. It is a matter of some interest that the first of the

hundreds upon hundreds of patents taken out by that most prolific of patentees, Mr. Edison, was for an electrical invention of this character made by him in 1869. Long before that date, however, a very perfect apparatus for recording votes by electricity had been invented by F. J. Grace, a well-known telegraphist, now deceased, and a working machine was shown by him before a Congressional committee at Washington. Schuyler Colfax, then Speaker of the House, assured the inventor that the minority could not secure the introduction of such a machine, while the majority had not the slightest desire to diminish the time consumed in taking a vote by the antiquated and cumbrous process of calling the yeas and nays one by one. It is certainly to be hoped that the new invention may meet with better encouragement but we confess we have our doubts about it.

A CORRESPONDENT of *Electric Power* states that two miles of the six miles of double track cable line of the Denver (Col.) Tramway Co. has been converted into an electric line. The system comprises three straight lines radiating from a common center, where the power-house is situated, and the traffic is quite heavy, the cars running on two minutes headway. Considering the favorable conditions for a cable railway, the fact that the Denver company, after an extended experience, should, at great expense, change all their cable lines to the electric system, as they are about to do, may be regarded as significant. A consideration of the net efficiency of the two systems must lead to the conviction that any cable system must be utterly unable to compete economically with a perfected electric system, except in cases where the grades are prohibitive of locomotive propulsion of any kind.

IN a paper recently read before the Colorado Scientific Society Mr. Irving Hale presents one of the most valuable contributions yet made to the discussion of the problem of the limitations of distance in the economical transmission of power by electricity; a question which in the mining regions of the West is assuming great industrial importance. The world has been afflicted with much arrant nonsense on this theme from the mouths of authorities of high reputation who ought to know better, and who probably do know better. Mr. Hale makes a thorough analysis of the whole subject, subjecting it to the logic of cold facts and figures, without romance or guess-work. While freely admitting that under favorable conditions the application of the electric transmission of power in mining is "a successful and highly profitable reality," he strongly depreciates a certain tendency among electricians to look at the problem from a scientific rather than from a commercial standpoint. The general conclusion reached by Mr. Hale, and abundantly fortified by the figures adduced by him, is that wherever in a mining district the cost of coal exceeds $4 per ton, and water-power is available at a reasonable cost within a distance of not more than five miles, the installation of an electric-power transmission plant presents a very attractive investment for capital. But when it comes to greater distances, Mr. Hale's conclusions are supported by the opinion of an editorial writer in the *Electrical Engineer*, who recently pointed out that there must be an enormous reduction in the present cost of installation and maintenance before electric power from Niagara can be delivered, even no farther away than Buffalo, to compete commercially with steam now manufactured in that city at $35 per horse-power. There is much danger that capitalists may be led astray by visionary and uncommercial projects of this character, and the note of warning uttered by conservative electricians comes none too soon.

AN isolated electric-lighting plant has recently been installed in London which is being successfully operated by an American windmill. The dynamo is fitted with an automatic switch which cuts in a storage battery of 28 cells whenever the voltage of the current reaches 70, and cuts it out when it falls to about 50. The current is of course variable, but with a fair breeze

is about 30 amperes. The regulating resistance in the shunt of the dynamo is controlled by the action of a centrifugal speed governor. Two arc lamps and a sufficient number of incandescent lamps to light a large flour-mill, are supplied with current from the storage-battery. Mr. Charles F. Brush erected a similar plant in Cleveland, O., a few years since, bnt we have seen no recent account of its performance.

ALTHOUGH it is scarcely half-a-dozen years since the advent of electrically-propelled street-cars with the overhead system of distribution, there are now more than 400 such lines in operation in the United States. It is a very significant fact that notwithstanding the outcry which is kept up against the "deadly trolley" in certain quarters, it has never been abandoned where once introduced, either from failure to perform good service, or on account of objections on the part of the public. As one authority pertinently observes: "We have seen electric storage-battery cars, stored-steam cars, stored-air cars, gasoline-propelled cars, and noiseless steam-motors in a dozen forms, tried and carefully tested by the largest street-car companies, and they all failed." This, however, is scarcely just to the storage-battery system, which certainly possesses distinct advantages in its own field, though it cannot be denied that that field is likely to prove to be a somewhat limited one.

A NEAT method of braking electric locomotives has been contrived by Sidney H. Short, of Cleveland, Ohio. Instead of reversing the current, at the risk of serious injury to the motors, a switch is applied which disconnects the motors from the supply-wire and connects them with each other, in such a way that each motor, acting as a dynamo, tends to produce a current in a direction to increase its own field magnetism and cut down that of its mate. A rapidly-moving car can thus be brought to a sudden stop, or a heavily-loaded car may be made to creep slowly down a grade without the necessity of the application of the friction-brake. Such a device cannot but conduce materially to the safety and economy of electric-propulsion, and Mr. Short's happy conception no doubt will be adopted widely as soon as its merits are appreciated.

THE Atlantic Avenue Railroad Co. of Brooklyn, which has adopted the electric-trolley system, is pushing forward the construction work as rapidly as possible, and expect to have some portions of the line in operation in July. The power station will cover an entire block between First and Second streets, adjacent to the Gowanus canal, and has been laid out for an ultimate capacity of 5000 horse-power. Tandem compound condensing engines of 500 horse-power each are to be used. The first order for fifty cars is now under construction.

THE reports of the Gas and Electric Light Commissioners of Massachusetts give some idea of the extent to which the electric light is supplanting gas as a means of domestic illumination. According to the returns made to the Board, there were on June 30, 1891, 796,302 gas burners, as estimated from meter capacity, and 161,-259 incandescent electric lamps, the latter being therefore 16.84 per cent. of the aggregate number of lights. For 1890, the figures were respectively 759,493 and 118,-259, the proportion of electric lights being 13.47 per cent. In the matter of street and public lighting, the change from gas to electricity has been much more extensive. It appears that there were 79 municipalities in the State which maintain public electric lights. Of these 28 use the arc light, 5 the incandescent, while 41 use both. The ordinary price of the incandescent light for domestic purposes appears to be 1 cent per lamp-hour, which is equivalent to gas at $2 per thousand cubic feet. The average price of coal-gas throughout the State is given as $1.31 per thousand. In 1886 it was $1.72.

In a recent report to the Conseil Municipal of Paris, M. Paul Brosse has given statistics in reference to the relative positions of gas and electricity in that city,

from which it appears that notwithstanding electric competition the consumption of gas still continues to increase, though at a somewhat diminished rate, which accords with experience elsewhere. Of the 85,000 houses in Paris it appears that only 20,000 are supplied with gas. The consumption during 1891 was 10⅓ million thousand cubic feet. The present capacity of the central electric stations is given as 17,500 h. p., the capacity of the complete installation will be 32,000 h. p. The present number of incandescent lamps, according to the American basis of rating, would be something like 175,000.

IN the course of a recent trial of a patent suit in England, so good an authority as Professor George Forbes made the statement that he could mention no instance of a low tension continuous-current central station which was operated without the aid of storage-batteries, and that he had never seen steady lights produced without them, although he admitted that by "an expensive system of working and enormous care," it might be possible to do so. This statement will, we think, be read with some surprise by American electrical engineers. The employment of storage batteries in connection with a plant of any size is a thing almost unheard of in this country.

THE saying that it is an ill wind that blows nobody good, receives a new exemplification in the experience of the Westminster Electric Supply Company of London, whose chairman recently stated that the winter fog of that metropolis was the shareholder's best friend. During one week of almost continuous fog, the receipts for electric lighting increased from $4000 to $6000, a gain of 50 per cent. The managers of other electric lighting companies might do well to cut out and paste in their hats a further observation of the same chairman, to wit: "The cost of production will be greatly reduced as the total output increases, but all the economies before us at present must be simply the straightforward results of thoroughly good management and unremitting attention to details."

IN selecting Minneapolis as the place of holding the Republican National Convention this month, the important question of the sufficiency of telegraphic facilities appears to have been lost sight of by the political managers, and the officers of the Western Union company are not a little uneasy over the situation. Minneapolis lies on the extreme edge of the telegraphic system of the United States, and is practically reached only by one route, that from Chicago. In case of any accidental breakdown on this route the obstruction would be irremediable. The New York *World* estimates the amount of matter that will be filed for transmission by the newspapers of the country at about 330,000 words per day, all of which must practically be handled in about eight hours. It is not impossible to do this with the existing facilities, but in case some of the wires should become disabled, or some sensational episode should develop itself in the convention, calling for an increase in the volume of "specials," there is reason to fear that some of the newspapers, at least, will have to suffer.

ACCORDING to the London *Electrical Review*, there are now in existence 1168 sections of submarine telegraph cable, the aggregate length of which is no less than 143,011 nautical miles. Nearly all this vast length of cable has been manufactured on the banks of the river Thames. The maintenance of this network of submarine lines requires the exclusive services of 37 specially constructed and equipped steamers, having a total tonnage of 30,131 tons.

WHILE the Lauffen-Frankfort transmission-of-power plant was in operation, transmitting a three-phase alternating current at a pressure of 25,000 volts, experiments were made by the German Postal Telegraph authorities, to determine the amount of inductive interference with their lines. It was found that the influence of polyphase currents increased with the voltage, and was felt on lines placed at an average distance of 10 meters from the disturbing circuit, for distances vary-

ing from half a mile to 18 miles. Even on a double wire telephone circuit running parallel for 7 miles, conversation was rendered inaudible. It is stated that the Postal Telegraph authorities intend to push a bill through the Reichstag giving them full power to deal with conductors carrying "energetic currents." There is, however, great opposition to the bill.

AMONG the minor details of construction in a system of electric distribution for lighting or power in which currents of large volume and considerable pressure are employed, nothing is so important as a trustworthy safety-fuse as a safeguard against overheating of wires. In view of the admitted failure of some of these devices to fulfil their intended function, and the anomalous action under test, of some of the most approved and widely used forms, Mr. C. Kammeyer has experimentally investigated the subject with the aid of an ingenious photographic apparatus devised by himself, and has given some of his results in a recent lecture before the Chicago Electric Club. A study of Mr. Kammeyer's photographs seems to indicate that the danger to be apprehended from an alternating current is much less than with a direct current. Some of the results tend to show that in the case of an alternating current the fuse wire is evaporated or disintegrated from its external surface, while with the direct current the interior portion of the wire is first fused, bursting the outer shell and causing an explosion of the molten metal of more or less violence. A common defect in fuses was found to be the manner in which they are mounted and united to the circuit. They should be soldered, in order that the fusion may not first take place at the point of contact with the supports.

AT the Crystal Palace Exhibition, Sydenham, England, a room has been fitted up to illustrate various possible applications of electricity for domestic purposes. Among the contrivances shown are pumps, fans, spray-diffusers, knife and boot-cleaners, coffee-grinders, kettles, frying-pans, flat-irons, curling-tongs, foot-warmers, etc. Among other interesting demonstrations, the process of cooking by electric heat is performed, including the frying of mutton cutlets, chops and potatoes. The London *Electrician* thinks that care ought to be taken to point out, that at least for the present, "such electrical luxuries are only obtainable by those possessing ample means."

A NEW standard cell for the determination of electromotive forces, the value of which is unaffected by changes in temperature, has been brought out by Edward Weston. It is based on a discovery made by him some time since, that the electromotive force of the salts of cadmium is practically independent of temperature, a circumstance probably due to the fact that these salts are equally soluble in hot and cold water. It is stated that a range of 200° F. affects the electromotive force of the new cell not to exceed 1-100 of 1 per cent.

THE American Institute of Electrical Engineers, which was founded in 1884, holds its general annual meeting this year on June 6–8 at the Grand Pacific Hotel, Chicago. The programme is an attractive one, embracing papers from Prof. Elihu Thomson, Dr. E. L. Nicholls of Cornell, and many other distinguished electricians. A large attendance is expected, and the meeting bids fair to be one of the most successful in the history of this young and vigorous society.

THE West-End Co. of Boston have found that twenty-five foot electric cars are a little too large for economical operation during hours of light traffic, besides being somewhat injurious to the track, and the length of the new cars is therefore to be reduced to twenty feet. The company are also about to make a trial of fifty car-fenders of the so-called "Cleveland" pattern, upon which a commission of experts appointed by the company have reported favorably.

MECHANICS

Conducted by Frederic R. Hutton.

THE civilization of this century makes such an extensive use of heat-engines deriving their power from coal that the problems of its satisfactory consumption and of economy in its use will always be of moment. An especial interest, however, is given now to these questions when a movement is on foot in the inland cities using the softer varieties of bituminous or flaming coals, looking to the suppression of the smoke nuisance. The city of Chicago, feeling that its attractiveness is somewhat at stake, has organized a Society for the Prevention of Smoke, which is holding itself ready to advise with industrial establishments as to the best means of securing such satisfactory combustion as shall mitigate the smoke nuisance.

This state of affairs gives a special interest and importance to the discussion presented before the Engineers' Society of Western Pennsylvania, by Mr. William Metcalf, the well-known engineer and metallurgist of Pittsburgh, presenting as he so capably can some of the points which are occasionally forgotten when these matters are under superficial treatment. Mr. Metcalf says "the consumption of coal entails two processes: first, the conversion of carbon to the condition of gas or vapor, and second, the union of the carbon with the oxygen of the air." It is this second step which is the occasion of the intense heat with which we are familiar, and which is the result of the chemical combination which occurs when the carbon is oxydized; and the product of such complete union is carbonic acid.

The first step is not productive of heat, but, on the contrary, is actually absorbent of it, the process being equivalent to what is a distillation when it is effected in a closed vessel or retort. In soft-coal combustion, where there is a large amount of hydrogen compounds, the hydrogen gas is distilled off from the coal in the first step, and its oxydization produces water which goes off with the carbonic acid in the form of steam. It is obvious then that from perfect combustion, the gases which pass off should be invisible carbonic acid and invisible steam. If there is sulphur in the coal in perfect combustion, it will disappear as invisible sulphuric-acid gas and the solid mineral matters of the coal should remain behind in the form of ash.

THE smoke problem in industry has usually two distinct sub-divisions, relating to the smoke which comes from metallurgical operations and that which comes from the manufacture of steam. While in some respects the two forms of the problem have much in common, yet they differ enough to make it desirable to look at them separately. It is well known that carbonic acid is not a supporter of combustion. The ordinary domestic fire-extinguishers are constructed upon this principle, so that a fluid saturated with carbonic acid shall be thrown upon a nascent fire and extinguish it. When, therefore, the object is to maintain a perfect and satisfactory combustion, it is necessary that the proportion of carbonic acid present in the air over and about a fire shall be kept so low that the carbonic acid when formed shall be less in quantity in that atmosphere than the oxygen which is to support combustion. Therefore the flame which marks a perfect combustion is one in which or about which there is an excess of oxygen with its attendant inert nitrogen. It is bluish or violet in color, and is by no means the hottest variety of flame in its effect, either in the metallurgical furnace or under a boiler. More than that, it has in metallurgical practice a distinctly erosive quality due to the excess of oxygen present. It entails a loss of the metal to be treated and is very severe upon

refractory brick or other material in the furnace, or in the boiler-setting which may be exposed to it.

The yellow or white flame which we see in the combustion of illuminating-gas and in soft coal is a mixture of the hydrogen flame making steam as its product of combustion, the carbon flame making carbonic acid as its product of combustion, and the carbon rendered incandescent by their combustion. If this incandescent carbon can meet oxygen at a temperature high enough to unite with it, such union will take place and we get a smokeless combustion. If for any reason, the carbon should not meet the oxygen needed after leaving the place where its temperature is high enough to attain incandescence, it will, on cooling, appear in finely-divided black particles, which, darkening the invisible gases of perfect combustion, will be called smoke. This white flame is a feature of relatively imperfect combustion, and is the hottest flame for metallurgical work, and the best flame for boiler purposes. As we ordinarily see it, it indicates that there is not quite enough oxygen to produce the complete combustion of the bluish or violet flame, and consequently the material in the metallurgical furnace is not exposed to the danger of excessive oxydization, nor is it so severe upon the refractory materials of which the furnace may be composed. In the boiler furnace, due to its possession of incandescent matter in suspension in the current of gas, it acts to make steam by the transfer to the water of the radiant heat from the large radiating area where is the flame. It is for this reason in particular that the softer varieties of coal are admired for steaming purposes, apart from any difference of cost.

CONFINING attention to the steam-making side of the discussion, it may be worth while to call attention to the fact that the heat from the fire gets into the water in the boiler by radiation from the incandescent carbon, and by contact of the iron with the hot gases. Of these two methods for the transfer of heat, radiation is a great deal more efficient than the transfer by contact, depending in either case upon the difference of the temperature between the transmitter and the absorber of heat. That difference enters into the formula for contact as a co-efficient, and into the formula for radiation as an exponent; and a moment's thought will convince any one that with a given difference of temperature between the boiler and the source of heat, the transfer will be much more efficient by radiation. In the use of this fact in designing boiler-settings for coke or anthracite coal, where there will be but a short flame, and where the minimum supply of oxygen will be called for, we must depend for our heat mainly upon the radiation from the fire-box or furnace area, while with bituminous or gaseous fuels, that radiating area will be limited, not by the length of the fire-box, but by the length of the flame carrying white hot glowing particles with it. It is for this reason that there is any justification for the use of water in a boiler ash-pit or for the use of water in the fuel, the hydrogen from that disassociated water giving to a short flame fuel a superior radiating capacity. But in a boiler firing, it must not be forgotten that we are compelled in the furnace area to effect both the distillation of the carbon and the hydrogen gases, and their combustion.

When fresh bituminous or flaming coal is thrown upon a boiler fire, the first process is the distillation of these carbon and hydrogen products. There will appear a brownish or yellowish gas which looks like smoke, and which will eddy and billow out of the smoke-stack after fresh firing. This brownish or yellowish gas is not, however, a real smoke at all, although it masks as such, and is voted from a metropolitan standpoint as an objectionable feature. The color is mainly the result of the presence of tarry matter, as can be made manifest by holding in the gas some condensing surface like a plate. The material is sticky, but does not contain what is called sooty matter. By and by, when it gets hot enough, it can be ignited and will burn with a white and really smoke flame. During the period of this distillation, there is comparatively little

steam made, the heat of the fire being masked by fresh coal over its radiating surface, and being somewhat consumed for the formation of this distilled product.

This same process will happen not only with bituminous coal, but with any compound rich in hydrogen, such as wood, shavings or sawdust. It is to avoid this miscalled smoke that the coking method of firing is directed. If we can only distil this material from the solid fuel under conditions such that it can be retained, to be burned at a high temperature as gas, we have mitigated the loss and discoloration of the atmosphere during this stage of the combustion process. The old English dead-plate or coking method of firing was directed exactly to this end. The gas was distilled off from the coal charged upon the dead-plate by the heat from the fire behind it. The gases passing over the incandescent fuel on their way upwards towards the stack were raised to a point where combustion with hydrogen was possible; and if there was oxygen enough anywhere for the combination, the combination might be expected. When distillation of this gaseous matter has gone on long enough for this distilled carbon of the coal to begin to glow, we have the boiler fire at its best stage: a bright illuminating flame rich in incandescent solid carbon running for many feet under the side of the boiler and radiating its heat actively to the water of the heating surface.

DURING this period, whether or not there is smoke to be seen issuing from the stack will depend upon whether there are present the two conditions necessary for the satisfactory combustion of an illuminating flame of this type. These two conditions used to be succinctly expressed by the late Alexander L. Holley as "temperature enough and time enough," and nobody has very much improved upon his epigram. It is well known that a high temperature is necessary for a satisfactory union of carbon and oxygen. The temperature of a cigar-ash is usually not high enough to start the illuminating-gas at a house fixture; it requires the heat of a spark or a match-flame. Similarly, in a boiler-setting, where the boiler itself is a most efficient refrigator, being always at a temperature very much below that of a glowing cigar-ash, it is by no means an easy thing to keep the gases warm enough to secure a union which shall dispose of the carbon glowing in the flame as they radiate their heat to the absorbent boiler. It is to mitigate this evil that so many devices are presented by which the supply of air entering behind the bridge-wall shall be heated by flues in the walls of the setting, by the hollow bridge-wall or by the checkered bridge of fire-brick in the combustion chamber by which the temperature shall be raised.

The second condition, as to giving time enough for the union of the carbon in the flame with the incoming oxygen, is one which must also receive due attention. When a boiler is being over-driven and the draft is very strong, the flame may be carried past those parts of the boiler setting where ignition might take place, before an opportunity is given for the union to occur. In the case of multi-tubular boilers, wherein the products of combustion are divided into small channels as soon as they enter the tubes, we must expect that all prospect of combustion is over, and the carbon must go out in the products of combustion as lampblack, because within the tubes the temperature will of necessity be too low, the iron radiating off very rapidly the heat of the gas. It is for this reason that the small tube is ill-adapted for use where the fuel is a flaming fuel. The larger flue type will really utilize the heat from the fire and bring it to the water under these circumstances. This also shows why with certain conditions as to the amount of work to be done by a boiler, it is almost impossible to prevent smoke even with special appliances directed to that end. If the boiler has to be worked hard, it becomes next to an impossibility to attain the interval of time necessary for the union sought.

When the gas has all been distilled off, and only the solid carbon in the fire remains to unite with the oxygen which it requires to render combustion perfect, and the arrangements for the admission of the

air necessary during the distillation stage are not absurdly defective, the combustion is taking place with an oxydizing flame and is perfect; but the steam-pressure begins to *fall* because we have lost the efficiency of the long radiating flame and the products of combustion are diluted with air and nitrogen in excess. It is at this time that the fireman sees the wisdom of coaling anew as the indications of his steam-gages demand. If there are many boilers in a battery, these stages will be continuously over-lapping each other in the interest of keeping a steady steam-pressure, and consequently there will be smoke issuing from the stack at all times.

THE key to the situation would therefore seem to be the securing for the incandescent carbon a sufficient supply of oxygen at a high temperature to secure its perfect combustion after it has done its work by radiation to the heating surface of a shell; and the success of a device looking to this end must be measured by the completeness with which it attains it. A fundamental advantage would seem to attach to a device candidating for public favor in Chicago, which is called "The Chronometric Smoke-Consumer," whereby the admission of air to the fire and combustion chamber is made variable by a time-device, so that during the distillation stage more air shall be admitted than during the complete combustion stage. The difficulty is that barometric and other conditions affecting the rapidity of combustion will vary, and dampness of weather and variations in the elements charged make such a time-adjustment unsatisfactory. But if the object could be attained while taking account of the variables, it would be something better than an accidental regard to them, or more. The automatic stoking principle also, while it attains great advantage and economy, yet does so by keeping the boiler continuously under one set of conditions, which are not perhaps those most favorable with bituminous coal, to the fastest steam-making, but will prevent the strain due to an attempt to over-drive the boiler, and to make a small grate surface furnish a large amount of steam. This statement of the case is independent of the labor-saving features of the automatic stoker, which, for the present discussion, are aside from the question. In gas-firing with natural or producer gas, the conditions again are constant, but as before, perfect combustion in the fire-box is not the most satisfactory nor efficient condition. The perfection of combustion is to be attained after the radiating effect of the glowing carbon in the gas has acted, and consequently the products of combustion are apt to be a little smoky even with gas. If this object is sought, natural gas, being as a rule richer in carbon than producer gas, will ordinarily make the denser smoke, the carbon not being entirely taken care of. It will be obvious from the foregoing discussion that the term smoke consumption is entirely irrational, inasmuch as the finely-divided carbon in the form of lamp-black, when once formed, is perfectly incombustible. The proper object of all devices looking to the mitigation of the smoke nuisance is prevention of smoke.

AN interesting commentary on the foregoing discussion is found in the appendices to the most admirable report presented by a committee appointed in St. Louis to consider the subject of prevention of smoke. These show that there is a loss of power and of economy in some experiments to produce a smokeless combustion under a boiler, the greatest loss of power being 15 per cent. and of economy, 13 per cent.

This same report also enumerates most admirably the conditions which a smoke-preventing device must fulfill. These general conditions are three, and include: First, efficiency to attain the development of such a high temperature and oxydizing action as to insure the combustion of the free or separated carbon which forms the visible smoke; to secure regularity of action under the widely-varying conditions induced by fresh charges of coal, the cleaning of the fires, etc.; to secure freedom from derangement under a careless fireman, bad water or coal, and finally, to attain little if any increase in the operating cost. The second condition is that of capacity, so that the boiler will be efficient, not only

at its rated capacity, but even when forced; and the third, general applicability, including ready adjustment to all forms of boilers and settings; applicability where space is already limited at a comparatively low first cost; and with repairs, easy, cheap and small in amount, and that it shall operate without injury to the boilers.

The report also enumerates the prevalent devices in smoky cities to diminish the smoke nuisance, and refers to their unsatisfactory action under ordinary conditions. The first of these is the steam-jet idea, whose failing cases are when an excess of air is induced by them when firing is irregular, and the danger of injury to the boiler by a blow-pipe action. The second is the use of fire-brick arches or checker work, which with careful firing will produce good results. They are difficult to keep up, however, and necessitate frequent repairs. The third plan is the pre-heat of the air in the hollow walls. The difficulty here is to get air enough without interfering with the primary functions of the boiler-setting. The fourth is the principle of detached fire-boxes in which the coal shall be coked before it is pushed back upon the hot beds of fixed carbon. The difficulty here is, the maintenance of the fire-brick arches over the coking furnace. The fifth is the double combustion principle, where two grates are expected to be charged alternately with coal; the gases from the one where distillation is going on to pass beneath and thence through the fire-bed where the distillation has been completed. The trouble here is, to secure an adequate supply of air and the consumption unproductively so far as steam-making is concerned of the heat available in the fixed carbon of the glowing furnace. The sixth is, the downward-draft principle, whereby the distilled gases, instead of passing away from the top of the coal-bed, are drawn downwards through the fire, and so raised to the point of ignition. There is no direct communication over the bridge-wall as in the usual form of setting. This arrangement requires a water *tube* grate with the difficulty attendant upon this plan where there is any solid matter in the water to give trouble within the tubes. The principal difficulty is the lack of space, and the difficulty of applying this method to internally-fired boilers. The use of the automatic stokers is the final method, some of the objections to which have already been discussed above.

TO THOSE who have watched the development of wood-working machinery in this country, from the wooden frames which in the earlier days supported the moving cutting-machinery to the iron frame and massive types which the current practice approves, it is interesting to notice the similar passage to a more rigidly mechanical structure under the conditions imposed by the demands of the heavier and faster traffic on the part of the railroads. While perhaps in the earlier days of railroading a wooden cross-tie with the rail held to it by a spike met all the requirements of the time in a satisfactory manner, it is by no means surprising that the demands of the heavy traffic should induce favorable consideration for the metallic tie. The conditions in Europe, where the cost of wood and the difficulty of obtaining it of a satisfactory quality, at any price, have been before the transportation department of railway engineering for many years, are of course different from those in this country where good timber is cheap and attainable. It becomes also worth while to incur the increased first cost of the metallic ties, if on a crowded section of track the result could be secured that the work upon the track, once done, would stay done for a reasonable time.

These comments are called forth by the fact that Mr. Walter Katte, of the New York Central and Hudson River railroad, has decided to lay five miles of steel ties on the heavy-loaded and busy section of their track which runs from the Grand Central Depot to the junction beyond the Harlem river. These steel ties are to be of the A. J. Hartford patent, one-quarter of an inch thick, of a deflected trough section, weighing 100 pounds per tie. The rail is fastened to them by two clips seizing hold of the foot of the rail; the clips are secured to the tie by a bolt using the Harvey grip thread. The ties are to be spaced uniformly

at 36 inches centers, with an extra tie under each rail joint. They cost $2.50 per tie, including fastenings. While the wooden tie of Southern yellow pine costs 55 cents each, yet under the conditions of climate, and particularly the perpetual dampness prevailing in the tunnel section where these new ties are to be laid, the wooden tie can be expected to last, as a rule, less than ten years, and usually about seven, so that Mr. Katte gives it as his opinion that taking all things into consideration, there is a relative economy of from 8 to 12 per cent. in the long run, in favor of the metallic tie.

The advantages of the metallic system reported in the communication made by E. E. R. Tratman to the United States Department of Agriculture, are, first, the superior and more effective fastening of the rail to the tie; second, a better hold of the metal cross-tie with the curved ends in the road-bed ballast, thereby preserving alignment more effectively on both straight lines and curves; third, the increased resistance to a tendency to overturn upon curves, and to creeping on grades; fourth, the clip-and-bolt fastening makes double-spiking and rail-braces unnecessary on curves; fifth, incombustibility and safety from coals dropped from engines; sixth, the commercial value of the scrap material.

THE increasing use of wire rope, either in cables or for the transmission of power, gives increased interest to the means available for the protection of such rope. The cost is considerable when renewal is necessary, and the conditions under which the rope is used make it difficult, as a rule, to protect it. The primary requirements which a protective covering for wire must fulfil are summarized adequately in a recent note in the *Engineer* (London). They are, first, imperviousness to moisture and gases; second, adhesiveness to the metal which it is intended to protect; third, flexibility, so that the coating may be free from a tendency to break when the cable is bent, and fourth, hardness to withstand attrition. The coating must also be one whose process of application, or subsequent presence on the wire, shall be free from injurious action. An interesting commentary on the capacity of the covering to withstand attrition, is made in the decision of the engineers who have agreed that the contact surfaces of the grip mechanism for the cable road to be operated on Broadway in New York City, contrary to the usual scheme in such apparatus, (which is to make the jaws of some soft material with the idea that it shall wear away and save the rope) are to be made of highly hardened steel, on the principle that the soft material, under the street, would permit gritty particles to imbed themselves therein, and thus increase the abrasive wear of the cable during the slip when the cars are starting from rest. The principle seems to be a sound one, and its practical application will be watched with interest.

THE ordinary method of protecting wire rope is by galvanizing, which is to coat the rope with zinc; but this zinc coating is apt to crack, both in the manufacture of the rope and in its use; and experience shows that in the use of steel rope there is danger lest the galvanizing should diminish the strength of the rope by diminishing the strength of the individual wires. There appears to be a formation of a weaker alloy of zinc and iron upon what was the original surface of iron or steel wire, and second, the unequal annealing effect of the heat of the zinc on the wire produced during the coating process makes the whole rope less homogeneous. The proposed scheme of using lead as a coating offers some advantages over zinc. The difficulties here are to surmount the unwillingness of the lead to adhere to the iron, and to secure a lead which shall be electro-positive to iron instead of electro-negative, as is the pure lead. Lead is also cheaper, and its softness causes it to act as a lubricant somewhat as graphite acts in the ordinary fibrous ropes. Zinc still has certain advantages by reason of its hardness, and if it could be satisfactorily applied, as has been proposed, at a lower temperature than is used in ordinary galvanizing, the greatest disadvantages of lowering the tensile quality of the wire by over-heating, and a species of corrosion, can be eliminated.

ARCHITECTURE.

Conducted by Barr Ferree.

THE unexpected has happened: Philadelphia has felt the architectural revolution. This is the greatest news in architecture for many a day, for stated in the baldest manner that city is one in which there is the very highest appreciation for the very lowest architecture. Unpleasant as it is to say so, such is the only opinion that can be obtained from an inspection of her architectural wonders. Very much worse than this abysmal condition is the fact that the good folk of Philadelphia are delighted with the work of their architects, for otherwise it would be impossible for the creators of such structures to support themselves. But a new era is about to dawn. When a Philadelphia paper comes out in the blackest of type—as one did only a short time since—with the legend "Our Hideous Buildings"; "Philadelphia far behind other cities in architecture"; "Philadelphia streets are lined with architectural monstrosities," there is some ground for hope that the ceaseless battering of the critics against the buildings of that city have not been in vain. Nor is this all. A leading citizen speaks almost as boldly. "Philadelphia," he says, with that fine modesty only to be found in the natives of that great town, "is the only American city in the world. If there is a drawback to our progress it is this: any city which is sacrificed entirely to utility must eventually be forced to take a back seat." From an eminent citizen this is a tremendous admission, and there is some hope that that great barren waste of architecture figured on the maps as Philadelphia may yet lead her more advanced sister cities in the paths they should go. When a Philadelphian admits his city is ugly it is evident enough the days of miracles are not over, and there is no telling what may be expected.

If there is a sadder spectacle than the decay of a civilization it is the decay of a great exponent of culture and progress. It is quite bad enough to find absurd architecture in Philadelphia, where almost anything in this line might be expected, but it is a great intellectual misfortune to find that eminent journal of civilization better known as *Harper's Weekly* deliberately praising the very things that deserve to be condemned in Philadelphia buildings. The week that saw so much new hope for that city saw also the publication of a short article in *Harper's Weekly*, laudatory of one of its worst blocks. Seldom have so many absurd and false statements been gathered in so brief a scope. Within a single short paragraph the author misnames a well-known structure, finds a resemblance to an "entrance to a castle keep," in an arrangement that in no way resembles one, and dubs a structure in which Ionic columns supporting round arches make the central feature a "minaretted building" in the "Moorish" style. It is no wonder there is bad architecture in American cities—and Philadelphia is not the only American town—when reputable periodicals fill their space with such quintessence of nonsense. For the harm is not limited to its immediate circle. Less well informed people accept the utterances of authority without question, and it was quite in the order of things that certain Philadelphia papers should eagerly seize upon this mess of absurdity and use it as an argument for continuing the good old Philadelphia style. A single gem from one paper whose local pride had destroyed its common sense is sufficient to illustrate both the results of publishing stuff in respectable places, and the value of architectural criticism in Philadelphia: "Architectural criticism is worthless unless we know the name of the architect, because it is just as hard to find a man whose culture and taste are broad enough to appreciate the work of more than one or two architects, or, at most"—

for this monstrous statement is too much for even Philadelphia conceit—"more than one school of architecture, as it is to find in one person appreciation of more than one or two poets in poetry." What this means, how the various parts of this marvellous sentence are related to each other, and what poets would be out of poetry, are matters that may be respectfully referred for elucidation to the creators of Philadelphia architecture.

ORDINARILY the dedication of a church might be supposed to have no especial interest to the readers of THE ENGINEERING MAGAZINE. As a matter of fact churches are so important architecturally that no survey of modern architecture can ignore them. First of all they deserve attention because they are now almost the sole class of structures which the methods of an economizing and thrifty age permit to be treated in a monumental manner. The requirements of trade, the limitations of site, the necessity of obtaining the greatest rental from a given area, and a host of other elements not at all architectural, but very necessary and very pressing, so control the designing and erection of even large and costly structures, in which some artistic quality might perhaps be looked for, as to quite prevent any artistic or monumental treatment. We who deem it a shrewd piece of business to hide our opera-houses in the centers of great hotels or office buildings, who thrust our libraries up into the air and put five or six stories of offices beneath them, and who make architecture more a matter of business than of art, may consider ourselves singularly fortunate if we retain a single group of edifices that offers opportunity for the employment of artistic ideas. The commercial element, which has sometimes so disastrously affected other public buildings, has influenced our churches only slightly, and in them, therefore, we have some varied and artistic work of great interest. This is the more the case because the picturesque quality characteristic of current domestic work has thoroughly permeated modern ecclesiastical architecture. New York has been rather fortunate in having in her West-side a district almost wholly new in which some of the latest advances in church-designing may be seen in practical application. It is somewhat singular that one of the most thinly-settled districts is also one of the most abundantly furnished with churches, but this question is rather a religious or sociological one than appertaining especially to architecture. It is sufficient for our present purpose to remark on the extraordinary number of churches in this single region, and the extraordinary architectural feast that offers itself to any one who is disposed to take a short walk through it. Even though one should see nothing but the churches one would see more strange sights than would be supposed possible in so limited an area.

Yet this is only partly true, for while New York's West-side can boast some singular churches, it also contains some of the best buildings of this kind recently erected in New York or elsewhere. St. Agnes's Chapel, built by Trinity parish, for example, is a group that not only very successfully illustrates the latest advances in church architecture, but is very successful also as a piece of architecture. The modern church is not a building with a single room devoted to church purposes, with possibly a lecture-room, chapel or Sunday-school beneath, but it is a complete plant—to borrow an expressive engineering term—of church, chapel, Sunday-school, club-rooms, libraries, recreation-rooms—multitudinous accommodations for church work as it is now understood by the most active church organizations. This is well illustrated in St. Agnes's. Placed in the center of a large plot of ground there is enough open space around it to permit it to be seen on all sides, a rare advantage, fortunate for the church and for the spectator alike, a combination that does not always follow. The buildings include the church and morning chapel, a house for the minister and a parish building, containing offices, rooms for day-school and other apartments. Very wisely the basement of the parish building and of the church have been left unfinished for future growth. The same development of

structure may be seen in the new up-town Collegiate Church, the Protestant Reformed Dutch Church. This is based on Dutch models, is almost wholly yellow in tone, and sometimes very much so, and is in many respects the most open departure yet made in New York from the traditionary forms of church building. Yet notwithstanding its external peculiarities it is a group of structures as complicated and as well developed as those which form St. Agnes's. The church proper occupies one end of the façade, and is cruciform in plan with shallow aisles and transepts. Adjoining is a chapel or lecture-room and ladies' parlors, and beyond them again a building for a day-school. The group includes, also, janitor's apartments, pastor's study, choir-rooms, a consistory and various other minor rooms. All these parts are brought into close connection with each other, and the design harmonized by a porch, partly glazed and partly open, which is carried across the front of the chapel between the church and the school. It would be easy to extend the list, but the most noticeable characteristic of current church architecture is complexity of parts. With the exception of the Roman Catholic churches this is a feature of all the newest churches.

AFTER the general idea the plan. This of course varies with the special denomination and sometimes with the special church and its needs, real or imaginary. The liturgical churches, like the Episcopalian, will doubtless long adhere to the cruciform plan. Such are St. Agnes's, St. Michael's, and several other new churches belonging to this organization. The Protestant Reformed Dutch Church, St. Andrew's Church (Methodist Episcopal), the First Baptist Church, and All Angels (Protestant Episcopal) all exhibit the same general idea, though with individual variations. Few modern congregations are content not to have full view of the minister and pulpit or altar. Gothic churches, with their nave and aisles, separated by heavy columns, have therefore been deemed unsuited to modern needs. But aisles are a great advantage architecturally, and modern architects overcome the difficulty by reducing their depth so as to use them only for passage-ways, and confining the pews to the nave. This peculiarity is to be seen in nearly all the churches named above, and it admirably accomplishes its purpose of permitting the use of aisles in a useful manner without loss of architectural dignity. Transepts, likewise, are objectionable because good views cannot be had from every place within them. They are, therefore, now made as shallow as possible without depriving them of their identity. In St. Michael's the apse is applied immediately beyond them without the intervention of an arm or choir as in St. Agnes's. The galleries in them are brought slightly forward into the church with the object of increasing their apparent size. In St. Andrew's Church, which is planned on a Greek cross, the transepts are so shallow as to be scarcely more than recesses in the walls. One of the most novel modifications of the cruciform plan is shown in All Angels. Occupying a corner lot, the architect has adopted the novel idea of using a tower placed diagonally across the corner as the façade. The plan is a Greek cross with long arms joined by straight walls, making it an octagon. The key to the plan may be found in the clearstory, but it has the advantage of departing slightly from the traditional form and bringing the people much more into the church than would have been possible on the older plan.

IF the doctors are to be accepted as unquestioned guides these changes and modifications, which are so amply illustrated in recent churches in New York are but so many gropings in the dark, for the only "modern" plan they tell us, is the amphitheater. So eagerly are certain grades of architectural opinion absorbed by the unlearned that a very wide impression prevails as to the truth of this statement. When the Episcopal cathedral was under discussion last year a great deal was said about a "modern" cathedral, which, in the baldest form, was to consist of a tier of benches surrounding a circular space in the middle of which was to be placed the

preacher. It was an opera-house labelled "church." It is needless to go into a discussion of the merits of this singular idea. In truth it has no merits, and its only importance is the attention it has received from some who should know better. There have been several such buildings erected in this country, and the Peddie Memorial Baptist Church at Newark, N. J., is one of the most noticeable examples of it. The fact that it is an amphitheater deprives it of all value as an object of comparison with other new churches. Yet it is well to remember that the "modern" amphitheater church has not yet acquired sufficient popularity to drive out the old plan with which Christian traditions are most closely connected, nor has it any special quality to recommend it save the ease with which it may exhibit the beauty of the preacher to the admiring and adoring gaze of his congregation.

THE *Architectural Record* is making a collection of "Architectural Aberrations" for the benefit of its readers and the enlightenment of architects and mankind in general. In the current number it gives an architectural and literary aberration combined, a union that makes a dish of unsweetened rhubarb mild and tame by comparison. This new quarterly has made such a high standard for itself, and is edited with such thorough ability, that lapses from grace are more noticeable than they would be in a less careful publication. A writer who devotes half of an article on a certain subject to the consideration of other subjects quite foreign to the special topic at hand needs an attention from the editorial blue pencil that has been wanting in this case. An architectural critic who would censure the architect of a building for making it nine stories in height, when the other structures in the immediate neighborhood are only four or five has simply set forth on a fault-finding expedition that has deprived him of his common sense. Nor does he improve his case by stopping to praise three absolutely colorless buildings in the same locality which have no more to do with his subject than the paper on which his effusion is printed. So far as the object of his criticism, the Brooklyn Real Estate Exchange, is concerned, no defense need be made. He is quite right in condemning it; but why spoil his case by introducing foreign topics and lauding most uninteresting structures? Was he writing by the inch that he must spin out his stuff at all hazards? It is not unexpected that so reckless and untrained a writer, to use some of his own expressions, should seek to make his article popular and bring it to the level of the common herd by making use of that abomination "artchitect." The *Architectural Record* is no place for such rot as this, even in quotation marks, and its editor should see to it that its readers, who look for something better, should get what they expect. Wholesale condemnation is doubtless required in many cases, but it may be questioned if the *Record* would not be better fulfilling its purpose as an exponent of the highest architectural thought of the country by spreading abroad a knowledge of the really good work we have produced, than by filling its pages with grotesque criticisms of grotesque edifices.

THE splendid bronze gates which Mr. Richard M. Hunt has designed for Mr. W. K. Vanderbilt's new villa at Newport, are engaging the attention of the press throughout the country. It is well they should, for if not the finest piece of work of their kind America has yet produced, they certainly rank among the most important. As is so frequently the case when a man of wealth expends a large amount of money in some personal gratification, the moral sages of our newspapers have not hesitated to print their little homilies in view of the great sum these gates have cost. The New York *Sun* with that fine consistency so often shown by great molders of public opinion, the more noticeable because its editor resides in a palace on an island in Long Island Sound, and has evidently forgotten the adage anent glass houses, takes occasion to remark that "It will not contribute to making the doorway to Mr. Vanderbilt's new Newport house more homelike and inviting, perhaps, but if the end aimed at is

rich display, surely the passer-by will be rewarded for the time he may pause to contemplate these splendid gates." And what business is it of the *Sun's* or of any one's how gorgeous Mr. Vanderbilt may make his summer residence? What have we to do with making his doorway homelike and inviting or why should any one express an opinion upon these qualities of which Mr. Vanderbilt is alone competent to judge? There is no more mistaken notion than that the expenditure of large sums for single purposes by the very wealthy is to be deplored. The harpies of the press are quick to pounce down upon just such things as the ordering of these gates because they cannot have the like themselves. The lesson to be taught by these monuments—for the work is important enough to justify so imposing a title—is that we have one rich man among us of sufficient taste to put a very large sum into the production of a single adornment of his house, and is still further liberal enough to place it at his very doorway, where all the world may see it, profiting both by the genius of the designer and the public spirit of the owner. Works such as these already famous gates are too rare in this country for any one or any organ to sneer at their lack of "homelike and inviting" qualities. Any man who places a great work of art freely before the public is a benefactor to his fellow men. Rich men and rich corporations too often fail in their artistic efforts to render it wise or just to censure any who may succeed.

MAY 2, 1892, deserves to be celebrated as Gaine Day in New York for all time. Gaines, it will be remembered, are partly-carved individuals such as may be seen in the lower part of the Broadway front of the *Mail and Express* Building. On May 2 these works of art were unveiled to the eyes of an astonished populace, and they fully warranted the ceremonies held over them and the large crowds that stood, open-mouthed, before them. There are a certain class of monuments which need to be seen rather than described, and of these the Gaines of the *Mail and Express* are shining illustrations. The lower part of the city is the favorite hunting-ground of a large maimed population, but there has been nothing in the career of "the leading evening paper" which should cause four legless and armless individuals to take up their position for eternity immediately outside its counting room. But the Gaines of the *Mail and Express* are shy and timid individuals compared with the half-clothed persons who support the windows of a new apartment house on Twenty-third street near Ninth avenue. Without exception these last are the most amazing things in sculpture yet inflicted upon New York. There is some consolation, though a sad one, in the fact that being but scantily clothed it will be impossible for them to long survive the rigors of winter.

A PACKING-BOX, a huge cheese and a paper cornucopia are not the elements one would most wish to see combined in a great national memorial. Yet it is hard to see that anything but these form the basis of the accepted design for the Grant Tomb. The Grant Tomb must be built; there is no getting away from that fact; it is only the greater pity, in view of its imperative necessity, that so important an enterprise cannot be commended on artistic grounds. Of course it is the rashest of rash criticisms to criticise a structure before it has scarce been more than begun. Yet every opportunity was offered for the making of a truly artistic memorial. It was the nation's greatest hero, save one. It was to be the offering of a thankful people to one of their greatest men. And it was an offering of a rich people, overflowing with wealth and culture and education, familiar with all the great works of former memorialists, as well as with their own previous attempts in the same direction. No more worthy object could be imagined, no greater enthusiasm conceived, than should have been called forth and manifested in this enterprise. In due season the real nature of what should be the nation's greatest monument will be apparent to the world. The prospect is not one that any American artist or architect can look forward to with equanimity. Yet the monument must be built; good or bad, success

or failure, the structure must be completed. Then we shall see whatwe shall see.

The most impressive memorials to the dead are of a religious character. There is a solemnity and grandeur in the tomb of Napoleon under the great dome of the Invalides that could have been had in no other burial place. One of the most impressive tombs in England is that of King John before the high altar of the cathedral of Worcester. Close by the Holy Place these two monuments stand supreme among the memorials of the dead. Yet it is not the form or shape or modeling of the tomb itself that impresses, but the architecture of the building and its dedication to the most solemn purposes. The dead Emperor and the dead King sleep eternally before the Eternal. It is the religious atmosphere of the place that impresses one more than the most gorgeous of mausoleums could possibly do. The idea is an impossible one of course, and therefore useless, but had the movement to build a tomb for General Grant and the Episcopal Cathedral in New York been united in one enterprise the result—supposing a real cathedral design had been chosen—would have been vastly more satisfactory than the double enterprises now undertaken. In the center of a great church the lowest monument to the national hero would have had a value and an impressiveness that can never be had in a gallery of painting and sculpture. It is this fact, the multiplicity of monuments, and the multiplicity of amazing monuments, that robs Westminster Abbey of much of its solemnity and makes it more a museum of the dead than a sacred structure put to sacred uses alone. Westminster Abbey is rich in the holiest memories of the English race, but the tombs of the great buried there lack that character they would have had from isolation.

THE most important members of the architectural profession are the professors of architecture in the technical schools. Much more than practising architects they influence the architectural thought of the country, because each day it is becoming more and more common for architects to derive their elementary technical knowledge in the schools. It follows as a natural consequence that the utterances of such men on any architectural question acquire a weight that belongs to no other authority, and if perchance the writer or speaker is connected with one of the most important architectural schools of the country, it is a matter of no small difficulty to estimate the good he may do, on the one hand, or the evil he may encourage on the other. Prof. A. D. F. Hamlin, the accomplished assistant professor of architecture in the School of Mines of Columbia College, has but recently completed a brief series of papers on modern architectural methods and materials entitled "The Battle of the Styles." The subject is a good one, the author thoroughly equipped for his task, and this treatment, on the whole very satisfactory, but his articles remind us somewhat of a fundamental principle in rhetoric as taught in undergraduate days. "First," said the professor, and he said it with a reiteration that has remained with us, lo! these many years, "first have something to say, then say it as well as you can." So Professor Hamlin, after a rapid glance at the battles of the styles, finds the comforting conclusion that we may use almost any style if we use it well. Perhaps so, but the author does not dwell sufficiently upon the point of the whole matter contained in the little word "well." This is really the source of all the troubles with the modern use of styles, that they have not been done well, and the Professor would have better served his purpose had he insisted more strongly on this point. Strangely enough the author finds much comfort from the distinctiveness of some American designs. As he truly says, we have a number of structures which would be recognized anywhere as examples of American work. Just so; Philadelphia has many buildings which could be at once located as belonging to that city, but no one save a Philadelphian would take any comfort in the fact, unless it were that they could not belong elsewhere. Distinctiveness and originality are prime elements in the creation of an architectural style, but these qualities alone have no merits of their own.

CIVIL ENGINEERING.

Conducted by T. Graham Gribble.

AMONG the transactions of the British Association is a paper by S. M. Burroughs on "Free Travel." While advancing no new theories the author dwells clearly and forcibly upon the general advantages to the community from such an institution. He states that in the vicinity of Melbourne the children are carried to and from the free schools without charge. He cites the care of elevators in public buildings in the following terms:

"Until the several upper floors of a new building are connected with the ground floor by stairways, the upper floors are comparatively valueless, but when the stairways are put in the upper floors begin to have a value. If these floors are made still more accessible by elevators, the value is still further increased. No company fitting up a large building for rental would think of letting another company put in elevators and charge a toll on their tenants. They would know that such a course would depreciate the rents of the upper floors. On the other hand they make the use of the elevators free to the tenants, and more than recoup themselves for the cost by the increased rental value imparted to the upper floors. The situation, with reference to free travel on railways and tramways, is the same, only that passengers would not be carried up and down, but to and fro laterally instead of vertically."

Mr. Burroughs further illustrates his point by the free ferry at Woolwich and its bearing upon land-values on either side of the river, as an example of how free travel could be secured without burdensome taxation, by simply taking the increased land-values imparted by making travel free to pay the cost of the same. It would not tax any one's industry, but simply appropriate for public uses one of the effects of the public enterprise. Mr. Burroughs seems to have read Henry George. He might also have cited the case of the railroad through the main street of Oakland, Cal., which traverses the entire length of that city without pretense of protection, but to atone for its many transgressions of the sixth commandment, carries the people free.

As a general principle, there can be no question that judicious means of communication increase the value of property to an extent so much greater than is represented by the cost of the enterprise that an assessment for purposes of construction would not ultimately be appreciable in the reckoning. The history of railways everywhere shows that a few far-seeing and public-spirited men have had to shoulder the task, generally at financial loss or even ruin, because the majority of the people were either too stupid or too selfish to back them. When the thing is demonstrated by practical proof, the "hogs" step in and get all the plunder by manipulating and then buying up the stock at less than the cost of construction or else, owning real estate, they quietly reap the benefit without having paid anything for it. On the other hand, a great deal of railway-building has been done recklessly, badly, and in consequence extravagantly by mere schemers. The sum of the matter is that the greatest of all the public benefits of civilization is disfigured with a black eye on its character as a vast commercial undertaking.

It would not be consistent with the principles of civic liberty for the higher authority to force a railway by means of taxation upon a district in which the majority were opposed to it, but State aid in the form of loans in which repayment was provided for upon increase of land values would often effect the launching of an enterprise which otherwise has either fallen through or has dragged its way through long years of costly obstruction and litigation. State countenance alone, having the guarantee of investigation by competent scientific

and financial experts, would of itself both solidify and expand the principles of railway development. To get to bed-rock, those who find the money should be assured of an honest, independent and broad-minded representation of the prospects of the road. Under the present system they cannot expect anything more than a fairly honest, but *ex parte* statement, and they often get something very different. The result of unexceptionable assurances to capital would be the obtaining of money at its value instead of on usury. Thus far we touch only the question of construction and the principle of making the improved real estate or (to be more explicit) the increase in value created by the road pay for its construction instead of outside schemers.

THE realization of free travel includes the assessment of the real estate with cost of maintenance and operation. A road does pretty well if it earns 5 per cent. on its cost of construction. The outgoings are say 60 per cent. of the gross receipts or from 6 per cent. of cost of construction. If, as is frequently the case, the real-estate values were such as to permit of the wiping off the entire cost of construction in two or three years from increment alone, the cost of maintenance and operation, still a charge on increment alone, would form an ever-diminishing fraction soon inappreciable in the reckoning. Property would be acquired subject to a fixed charge for railway maintenance similar to the ground rents of houses and the sale or transfer, including this item, would not be complicated in any way.

So radical a suggestion even to these times naturally bristles with difficulties. The first and foremost appears to be that a number of people who stay at home, possibly bed-ridden, would have to pay to keep other people riding about. When it rained, tramps would very probably prefer a seat on a street-car to one in the park and retain it with much perseverance. Competition being eliminated, working expenses would probably be swelled by sinecures of the Tite Barnacle type. There would be less avidity on the part of the general public to mulct the management and therefore themselves for the maiming of fellow-citizens than there is under the present company system. All these objections are however removable. The more one thinks over the idea, the more does it seem to rise above the horizon as a probable development in the near future of the progressive spirit of the age.

IN our brief notes last month upon the great bridge proposed by Mr. Lindenthal for the North river, the intention was stated of continuing the subject this month. We do so fully cognizant of our liability to misapprehend general drawings and descriptions pending the publication of details and equally alive to the powers of the engineer to meet and remove many difficulties which occur to the casual observer. We will now allude to what would naturally suggest itself as a difficulty in the great bridge by reason of variations in length of the several members under alterations of temperature. The application of a rigid system of bracing to a pair of flexible cables to which we drew attention last month has a further bearing upon the question of how to meet the alterations of length and oscillations of position in the cables. It is calculated by Mr. Lindenthal that the maximum range of movement at the outer will be 8 feet. Assuming that the cables form, when the bridge is completely erected, a pair of precisely identical paraboled curves, the vertical distance between them will still tend to be constant during the temperature movements but the lengths of the vertical web members will vary about half an inch. If the load is to be suspended equally from the two cables it is necessary that the vertical web member should at all times preserve the same vertical distance between the cables. If for instance in the hottest weather the vertical web member is of such a length that the pull of the bridge is equally distributed upon the two cables; when the cables rise 8 feet by cold, the vertical web member being half an inch shorter will throw all its load upon the upper cable as well as the load of the lower cable itself. Vice versa if arranged in the opposite manner all the

load would be thrown in hot weather upon the lower cable. If erected at an average temperature with an equal bearing upon the two cables the cables would act alternately at the extremes of temperature. This action would not be realized perfectly because the strains resulting therefrom would cause alterations of length in the web members but the tendency forms an interesting problem.

There is a further point which prompts enquiry, namely the action of the temperature oscillations of the cable upon the roadway. The design shows provision for fourteen tracks carried in a kind of open tubular bridge 40 feet deep and double decked, looking in cross-section something like a railway depot. It is not intended by the engineer that there should be in this manner a composite structure in which part of the support is divided from the double-decked roadway. This part of the structure is intended only as a means of distributing the load over a number of panels but it forms in itself a bridge having an enormous moment of inertia. As the cables rise and fall this roadway system must rise and fall equally, being suspended from it. The normal deflection of such bridges under proof stresses is about 1 inch per 100 feet or 31 inches for the span proposed. If however it has to move 8x12= 96 inches, the question suggests itself how such a structure can be made so flexible as to deflect to that extent without developing abnormal stresses within itself. It is, however, only about $\frac{1}{80}$ of the total span in depth and it may quite well be that its moment of inertia is not sufficient to cause great stress under that deflection.

The primary calculations have been performed by graphic statics which is a simple and most satisfactory method for simple structures. It would occur to the casual student that the bridge was composite not only from the stiffness of the roadway but also from the construction of the web members, and as such only capable of being correctly computed by analytical methods, but if methods have been found of completely calculating such a bridge by the graphic method it will be of great value in similar bridge-building.

ONE other point only occurs to us to mention here and that is the stability of the towers. It was stated by Mr. Lindenthal in his address before the American Association for the Advancement of Science that the cables will rest on the towers in large saddle castings on steel balls, capable of movement, but that they could with perfect safety be made rigid by allowing the towers to bend eight inches either way to accommodate the changes in length of the cables.

If, however, the cables were made rigid in this manner the effect of unequal load would, in its highest possible condition produce a deviation from the perpendicular in the resultant at the tower, and assuming the dead load as 3½ times that of the live load it would appear to bring the resultant rather near to the base of the tower. As contrasted with the masonry towers of the Brooklyn bridge, the North-river tower appears designed with very much more stability especially as the material of the tower itself would permit of the resultant passing entirely outside it if the feet were sufficiently anchored into the foundations. The efficiency of any adaptation of the suspension system is, generally speaking, measured by its capacity for dealing with high ratios of live load. The North-river bridge is designed to extend the suspension principle to the handling of far greater live loads than has ever yet been attempted in this manner but the ratio is still not large because the deadload is proportionately great. A high ratio of live load requires either a large movement in the saddle or else produces a greatly deflected resultant in the tower. The former produces more deformation, the latter more stress. Both are necessarily present in every structure, and it is in the obtaining of economic conditions regulating the effect of the load in producing minima of each which sums up the problem.

MR. ALBERT SHAW, in the April *Review of Reviews*, has done good service to the cause of municipal reform by bringing together the salient characteristics, both good and bad, of New York and London civic systems. In these days of omniscient and cosmopolitan newspapers, it is by throw-

ing strong light from one country to another that reformers can furnish their quiver and furbish their side-arms. Pulpit thunder, press satire, disclosure by experts, and the hard figures of the economist are all awake against King Boodle. He sits enthroned on the beer-barrel but his seat is growing less secure for the coming conqueror is Business Principle, which must sooner or later reign in the council chamber of the city as much as it does in the store. The development of the city will have to be conducted upon a cash basis, that is to say, the people who find the money will have to know where the money goes.

Mr. Thomas Curtis Clarke has contributed to the May number of *Scribner's Magazine* the first of a pair of opportune articles on rapid-transit in great cities. Mr. Clarke treats the subject with his well-known ability and embellishes it with maps of the great cities of Europe and America. We may expect in the June number a solution from Mr. Clarke's point of view which at all events will be worthy of study.

THE committee appointed by the Western Society of Engineers to consider the problem of transit in Chicago handed in their report on May 10, to a meeting of the society convened in the Rookery building. The committee consist of Richard P. Morgan, chairman; Isham Randolph, secretary and treasurer; Hierd B. Herr (elected on the death of Col. R. B. Mason) Benezette Williams, Gen. Sooy Smith, E. L. Corthell and Oliver B. Green. The report is based upon the inspection and study of the railway terminals in the cities of Baltimore, Philadelphia, Jersey City, New York and Buffalo; also of the new St. Clair tunnel. The object of the constitution of the committee was to obtain the mature judgment of the best experts upon the railway problem of Chicago in relation to terminals, rapid-transit, marine commerce, and other interests. The report is a voluminous one and includes a minority report by Mr. Corthell favoring elevated terminals and another by Mr. Randolph advocating a lake harbor in place of the present river docks.

The report states that 95 per cent. of the street-crossings of Chicago are at grade, and that this city is in a worse position than any of the aforementioned cities visited by the committee as regards safety to pedestrians. The sum of the report is as follows:

The facts stated show that the existing railroad conditions in Chicago involve great sacrifice of human life. To change these conditions is simply a question of vast expenditures of money. There are no engineering problems involved requiring originality, all of the forms of construction being well known and in use in other great cities.

In its bearing upon the marine commerce of Chicago, the report says that "if the city is to continue to lead in the commerce of the great lakes, its marine facilities must be improved; if Buffalo and Duluth will harbor vessels drawing 18 to 20 feet, while Chicago will not, then cheaper rates will ultimately prevail between the first-mentioned cities than between either of them and Chicago. Already lower rates both for wheat and coal between Buffalo and Duluth than between Buffalo and Chicago, notwithstanding 111 miles greater distance and the Sault Ste. Marie lock."

The report then suggests four ways in which the desired harbor improvement can be had, so far as the accommodation of vessels is concerned:

1. The Chicago river can be deepened and widened to any desired extent, and the present bridges replaced with more commodious ones, or the streets carried under the river with tunnels.

2. A harbor can be created on the lake front, and docks and piers built so as to accommodate all the shipping of the port or such part of it as is not transferred to the Calumet or done by lighters in the Chicago river.

3. The Calumet river and lakes can be improved and other interior channels made in the low lying Calumet region, and the shipping of the port done at that point.

4. Other entrances can be made to the north and south branches of the Chicago river, and the entrance through the main

river abandoned by lake craft and all kinds of vessels that cannot pass under bridges.

So far as the railroads are concerned the report says that the hope of relief lies in separating their planes of travel from those of the streets, which may be done in any of the following ways:

1. The railroads may be lifted entirely above the streets and highways to such a height that with streets running at their present grades, ample headroom will be afforded for all kinds of vehicular passage beneath the tracks.

2. The streets may be carried over the railways by means of viaducts.

3. The streets may be carried beneath the railways by using subways.

4. The railways may be depressed and operated in open cuttings and the streets may be carried at or near their present grades over the tracks thus depressed.

5. There may be a compromise between the first and third methods by which the railways may be elevated partially and the streets at their crossings of such lines may be depressed to an extent limited by the practicability of draining the depression.

The report concludes with the suggestion that an association should be organized for controlling by lease the terminal holdings of all the companies having such in Chicago, as a first step towards systematic treatment.

THE comprehensive and at the same time cautious treatment of this great problem by the committee demonstrates the many difficulties which hedge around its solution and it would ill become us to dogmatize, but a few passing sentences may not be out of place. The subsoil of Chicago not being suited to tunnels or cuttings, the place for rapid-transit is overhead. The maritime interests of Chicago are so immense and their normal development so greatly threatened by other lake ports by reason of the poor harbor accommodation that it becomes a matter of the highest importance to clear away the swing-bridges and obtain a deep-water harbor. The breakwater works have demonstrated the possibility of forming a lake harbor at very much less cost than other cities have had to pay for equal advantages. The cost of the exterior detached breakwater was only about $125 per lineal foot which is exceedingly small for a detached breakwater in from 24 to 31 feet of water. Cities with much less present and still less prospective traffic have had to pay two and three times this rate for their accommodation. The interests moreover are most diverse and conflicting. The Illinois Central Railway claim the riparian ownership of the lake from the Chicago river southwards for several miles and do not want any harbor there. To the north and south of these limits owners of residential property do not want the harbor. Nevertheless the great point to be considered is the destiny of Chicago as a maritime center either of first or second rank according to the facilities to be provided.

It appears to us that the most natural, the simplest and the most complete solution of the whole matter is to leave the railways where they are; to make a lake harbor for all shipping which will not go under a bridge headway of about 40 feet, and to carry the rapid-transit structures over the railways and over the river at that headway, providing sidewalks for foot passengers, and where necessary carriage ways also. All surface roads to be reduced to a speed of five miles an hour when passing through the city. There can be no doubt that elevated terminals for the trunk lines would afford a solution of the problem in one of its bearings, but it would cost much more to elevate heavy traffic than light traffic. The question of elevating sidewalks alone has been mooted again and again. The tall buildings are cities in themselves, and at certain seasons of the day pour forth their thousands into the already crowded streets. If elevated roads are decided on, the responsibility of the city is to obtain structures which will be sufficiently light and ornamental to be suitable to any thoroughfare; to obtain accommodation on them for foot-passengers also and to grasp the whole subject with the assurance which abundant experience affords.

American cities are emerging from the

"Topsy" stage of development, and realizing their destiny are laying themselves out to meet it. The consideration of the new lakes and gulf waterway cannot be left out of the consideration, and the scheme on its present lines contemplates the development of the Chicago and Desplaines rivers. The new waterway traffic does not, however, essentially involve this development; it could be handled by a class of vessels which would pass under bridges of moderate headway, and which would have their dockage in the Lake.

THE valuable treatise on irrigation canals and other works recently published by Mr. P. J. Flynn, of Los Angeles, Cal., will be appreciated highly on this continent. It forms a handsome book—two volumes in one—of 711 pages, with 92 tables and 211 illustrations, and it should form part of the library of every hydraulic engineer. The author has in the first place brought to bear upon the subject the results of extensive experience in India, where the works of irrigation form the chief feature of British civilization. He has further succeeded in collecting together a mass of information from all parts of the world, showing the different means which have been evolved by varying conditions for utilizing this gift of Providence. Mr. Flynn adds to the value of his book by citing the works and views of numerous other authors of well-known ability and experience, such as Captain Humphreys, Captain Berthond, A. D. Foote, George G. Anderson, Walter H. Graves in America, and foreign engineers too numerous to mention.

The theory is carried forward from the outset accompanied by practical illustrations. Velocity, erosive power, transporting power, silting, etc., receive comprehensive treatment and some points are elucidated which have been more or less misstated in older treatises. The works of civil and mechanical engineering connected with irrigation are fully dwelt upon. Among the sluices appears the ingenious equilibrium sluice of Mr. F. G. M. Stoney, who is well known for his valves and sluices on the River Weaver and the Manchester Ship-Canal. The subject of aqueducts and flumes naturally finds principal illustration from California, but the magnificent Solani aqueduct of India receives due consideration. The subject of retrogression of levels as affecting the regimen of canals is accompanied by illustrations of important mistakes in the adjustment of grades which yield the best teaching for future guidance.

The irrigating power or "duty" of water under varying conditions is as far as practicable analyzed and a table annexed. The collateral effects of forestry and the subject of rainfall are treated to some extent, and a table of the statistics of irrigation added. Evaporation, percolation and drainage are all successively handled, and the first volume closes with the full text of the author's report on the proposed works of the Tulare Irrigation District in California. The second volume consists mainly of formulæ and tables on the flow of water from Kutter, D'Arcy and Bazin.

The general make-up is in library style, with no lack of margin to the pages. Though somewhat bulky it is a very fine volume, and appeals not only to the engineer in practice but to the student, and is well suited as a standard text book for technical institutions.

THE first railway to Jerusalem will be opened this season. It is a short line running only from Joppa, the nearest port on the Mediterranean and intended to accommodate the growing passenger and other traffic between that place and the Holy City. The work of construction is being carried out by a French company who began laying track in April, 1890. Now that there is a railway from Smyrna to Ephesus and a projected railway to Babylon the romance and sentiment of travel in Palestine is on its last legs. Our friend, the Bedouin, will also soon have to "be dooin'" something else. Possibly holding up a train!

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

IF there has been any demand on the part of miners for the creation of a Department of Mines, it may have been deep, but it assuredly has been very still. It would seem reasonable to suppose that were there an intense, passionate yearning for a full-fledged Department of Mines—with a Cabinet officer at its head, an Assistant Secretary and Chiefs of Divisions, and clerks of high and low degree, and messengers, and charwomen—some evidence of it should be detected in such a great mining State as Colorado, where the very atmosphere breathes of mining. But no. The prevailing sentiment among mining men—this is said advisedly—is that Mr. Campinetti's proposal is undoubtedly well meant, and designed to advance the development of the mineral resources of the country, and to promote the welfare of a great and growing industry and all that; but they doubt very much whether the practical good to be expected would be at all commensurate with the cost. Experience has taught them what the outcome would be if the experiment were tried. Mr. Campinetti's plan does not propose beginning on an alarming scale; but they know, and every one knows, that such a Department once started could never be suppressed even if proved to be a failure. It would grow, and grow, and grow, just so long as there were members of appropriation committees, and Congressmen with votes, who had needy nephews and brothers-in-law to be provided for. Mining men fully realize that a central organization, with authority and reasonable means, with trained men to do the work under skillful executive direction, and animated by some interest higher than that of drawing their salaries, could be of substantial benefit to the mining industry in gathering and disseminating information, and in many ways. But they do not hope for it.

An illustration of what *might* be done is furnished by the Departments of Mines in the Australian colonies and New Zealand. Possibly there may be complaints about these, but if so they do not reach us. Here the impression is that they are economically administered, and the work of their officers, as shown in the published reports, speaks for itself. But the conditions are different there. The mineral lands are in theory a prerogative of the crown, and in practice they return a revenue. The colonial governments are under obligation to do certain work, supervisory, statistical and educational; and this they are able to do well because the system of mine-inspection and obtaining returns has a legal force that does not obtain here, though some of our coal-mining States do enforce mine-inspection in a measure. Perhaps, too, the atmosphere at the antipodes is more congenial to Departments of Mines of a useful order, so that they do not run to seed in bureaucracy.

JUST now the efforts being made to secure a creditable exhibit of the country's mineral wealth for the coming World's Columbian Exposition are giving an impetus to the collecting, classifying, dressing and arranging of mineral specimens. The exhibit promises to be by far the largest and most complete ever before made or attempted, and those who see it and those who help to make it will learn much. It is well that general attention should be awakened, by some such event as this, to a matter which is of importance at all times, not merely on a special occasion and for a particular purpose. But besides the admitted value of mineralogical study, and especially that of the minerals of economic importance, for the knowledge to be gained and for the sake of the application of that knowledge in prospecting, both on the surface as the word is commonly understood

and also in the underground exploration of mines, and as a guide in hand-sorting ore, there is another point too often overlooked by precious-metal miners. It is worth remembering that a great deal of material, not only of the high-grade class but also that which possesses features of peculiar mineralogical interest, is worth much more as specimens than it is as a mere product for the smelter or mill. Miners often save especially handsome specimens of native gold and silver, yet they do not seem to realize that nuggets, wire and crystallized examples have a very much better market among the museums and private collectors, to say nothing of the regular dealers, than they have at the furnace. What is saved is usually for the possessor's own gratification merely, or to make a handsome showing in a company's office, as happened the other day when a specimen of wire silver from the Mollie Gibson mine at Aspen, Col., after being dressed down from ninety pounds and still weighing seventy-five pounds ten ounces, escaped obliteration. Yet the amount of valuable material, some of it almost unreplaceable, that is constantly being pounded up in the mills or going into the furnaces and being destroyed—as specimens—is something that would appall an ardent mineralogist, while on the purely utilitarian side the difference between the bullion value and the extrinsic valuation that is lost is often very considerable. For example good specimens of crystallized gold and silver often bring several times their weight value, either for enriching collections or to be made up into ornamental forms. In one case an enthusiastic collector gave $250 for a piece of quartz containing some cubical crystals of gold which would not weigh one-half an ounce. The waste sometimes goes on on a larger scale than the mere loss of a few scattered pieces. In a single collection made from an Idaho mine some $20,000 worth of specimens were saved without much trouble. But besides the native metals and the ores, a great many rare minerals, or specimens valued because of their crystallization or peculiar association, but having no value as ore perhaps, are met with in the course of mining—and are usually thrown over the waste dump. It is worth while to keep a watch for such material.

MACHINERY for coal-mining is at present confined to machines for undercutting, shearing and drilling, still leaving to the miner the work of charging, blasting, assorting, loading and timbering. Attempts are constantly being made to produce a satisfactory loading machine, with fair prospect of success, at least for use under favorable conditions; and there is of course some mechanical coal cleaning outside. A very thorough account of the existing stage of machine mining is presented by Mr. Lewis Stockett, of St. Louis, in the *Colliery Engineer*. The author points out that ten years ago, in this country, machine-mining for coal was looked upon almost entirely as an experiment, in which few had any faith or were willing to hazard capital. To-day the experiment has become an assured success, and, as Mr. Stockett says, machine-mining is fast becoming the rule and not the exception. The latest statistics at hand show that in Illinois, in 1890, of the total product, 23 per cent. was mined by machinery; while in the Fourth and Fifth inspection-districts of Pennsylvania at the same period the percentages were 43 and 34 respectively. There is no question that since then the use of machines has increased, both absolutely and relatively. The strong prejudice felt by the miners against coal-cutting machines at the time of their introduction, and also against the operators of such machines, has entirely disappeared.

IN metal mining so far the power-drills driven by compressed air, and the comparatively few electric drills, represent the whole progress toward machine-mining. From the first miners have never had any prejudice against these—certainly not in precious-metal mining. How much farther machine-mining may go in the case of metalliferous mines is uncertain, but probably not far. It might be practicable to introduce gang-drilling machines, such as have been used to a limited extent in railway

tunneling, that is machines which would put in a whole set of drill-holes simultaneously, but probably only in exceptional cases. There is a still more remote possibility that some form of rock-cutter, on the principle of the diamond-core drill, but vastly enlarged, may be devised; that is, a machine which would cut a deep annular groove four or more feet in diameter, leaving a block corresponding to an exaggerated core such as is made by the diamond drill, only very thick in proportion to its length, which could hardly be more than three feet in one section. Even then the work would have to be finished by putting in a center blast or breaking down by hand. Such an opening, circular in cross-section, might possibly be made in this way, through solid hard rock, and there would be no great objection to its shape for small single shafts; though for horizontal work the cross-section would have to be cut out to the usual forms, certainly so if timbering were necessary, so that there would be no special gain in the machine work. The idea is not a new one by any means; it was seriously advocated long ago, and was suggested evidently by the working of the core drill. The conditions are of course quite different, since it would be difficult to safely give the larger boring machine the speed upon which the core drill depends for its cutting action; and such a device would work very badly in soft clogging material. Then there is another faint possibility in the idea of a modified channeling machine, altogether different in model from any existing quarrying machine, but acting on similar principles, designed to cut out the perimeter of a shaft or gallery about as deep as an ordinary drill hole, the standing block to be broken out by hand or supplementary blast. Such notions seem altogether visionary now, yet we must remember that mechanical coal-cutters must at one time have seemed almost equally chimerical.

OF the billion and a quarter in gold produced in California, a very large proportion comes from hydraulic mining. The resulting débris (the tailings from the mines) has done much injury to the navigable streams and also to agricultural lands bordering on them. Some years ago the farmers secured legislation which enabled them to enjoin and close down the larger part of the hydraulic mines. In this they not only injured the miners but indirectly themselves and the State at large, as they have since found out; for it cut off an annual output of about $10,000,000. Now the importance of resuming this branch of mining is deeply felt, but there being apparently no recourse within the State, Congress is asked to establish a débris commission under the Engineer Corps and to grant appropriations for building restraining dams, the outlay to be recouped by a tax of 3 per cent. on the gross bullion product of the mines involved, and the amount of mining to be regulated. From an engineering point of view the plan seems to be the only one which would admit of the resumption of mining. In brief, it consists in building very large rubblework dams at favorable points, with stone and brush wing-dams to control the flow. Few hydraulic mines are so situated that they can impound their tailings immediately below their works; they have difficulty in obtaining fall for the tailings as it is. Hence the need for a restraining system on a large scale. The plan is well matured and is endorsed by eminent hydraulic engineers. Some doubt is expressed whether the scheme can be carried into effect through the proposed method of administration. Beyond the engineering problem is also the political question whether the Government should intervene; but as the Government assumes the care of the navigable streams, and as the restraining method is cheaper than dredging, there is precedent for action. In any event dams are needed, whether mining is resumed or not, to restrain the old tailings, which are constantly coming down, together with the natural detritus.

THE cyanide process is making a gradual but steady advance both in practical results and in favor. At first metallurgists were inclined to disparage it, as was but natural in view of the disappointing experience

had with the "process men" as a general thing; but as actual demonstration on the working scale could not be ignored a considerable change of opinion has been brought about. The quiet, business-like way in which the McArthur-Forrest people have been introducing their process, without flourish of trumpets but with plenty of hard work in testing its capabilities, also has undoubtedly had a prepossessing effect. In its present stage of development it is not definitely known what are the limitations of its applicability. Any lixiviation process aiming to treat successfully almost all base gold ores and also a wide range of doré ores in which gold is the more important element, has before it a very complicated problem indeed, and time and a great deal of experimenting will be necessary to a full understanding of all the possible contingencies likely to arise. The underlying principle, that cyanogen is a solvent for gold and not a solvent of the sulphides of the base metals, is simple enough, and it would appear easy to put in practice this very useful selecting quality; but as with all lixiviation processes, there are difficulties to be met in working out all the details of a complete practical process. As is well known, the method followed is, in brief, to treat the crushed, raw ore in filter-vats with a weak solution of potassium cyanide (about half of 1 per cent.), the solution being preferably introduced below the false bottom under pressure and drawn off at the top, thus obviating in part the difficulties met in leaching ore that does not filter well by the descending method. The solution is allowed to stand a certain time (say twelve hours) and is then drawn off and fresh solution passed through continuously until the gold is extracted (which may take thirty-six or forty-eight hours more). The solution passes through a box filled with fine zinc shavings, which precipitate the gold, thence to the standardizing and reservoir tanks, and so on continuously. The precipitated gold is washed from the zinc by plain water. It is claimed that the consumption of cyanide does not exceed three pounds per ton of ore treated. The same solution is used indefinitely, being brought up to standard by fresh additions of cyanide as needed, which is a great advantage where water is scarce. The working results are claimed to be a saving of 90 per cent. to 93 per cent. of the gold, and 75 per cent. to 90 per cent. of the silver. As to this, we at last have something definite, in the report (April 19, 1892) of the superintendent of the Mercur mill, Utah, where amalgamation proving a failure on the base ore the plant has been converted into a cyanide leaching one. His summary is "1500 tons of our ore treated by amalgamation gave an average extraction of 20 per cent. at a cost of $4.25 per ton; 1600 tons of our ore treated in the past ninety days by the cyanide process gave an average extraction of 88½ per cent. at a cost of $2.25 per ton." It has been suggested that the process may not be applicable to ores containing appreciable amounts of copper oxide, which decomposes the cyanide and goes into solution. Oxidized iron and manganese do not decompose the solution. Whether the process will work upon ores in which the gold is chemically combined with other elements, as for example with tellurium in the telluride ores, and other possible combinations, is a question of very great importance, for there are ores of this class which resist simple amalgamation and are of too low grade for an expensive treatment or for shipping a distance to smelting-works. The cyanide of zinc taken up in the precipitation of the gold does not, it is said, affect the solvent power of the fluid, and either may be precipitated with sodium sulphide or allowed to accumulate to a certain degree of saturation and thrown away. Little by little the numerous details of the process are being worked out.

IT is a little surprising to find a professedly technical journal commenting on the use of flat hoisting-cables in the Hamilton and Chapin iron mines as a novelty. In the minds of most engineers the choice between round laid steel cables and flat woven steel cables was definitively settled at least fifteen years ago—that is, for certain work. For very deep vertical shafts

there can hardly be a question that the flat rope is the best. It can be more easily tapered than round rope, if the saving in dead weight to be hoisted is considered to be of more importance than the ability to turn it end for end or change the portions subject to most wear. It is much more readily inspected, and inspection shows its condition more accurately than with round cables. It can be repaired and spliced at the mine, and with proper care and attention in making the repairs as needed, its life can be prolonged almost indefinitely—somewhat like the old ship *Constitution*, whose frames and planks were replaced little by little without altering the original model. On the Comstock, and in fact in almost all of the very deep Western mines, the preference was almost always given to flat rope for vertical shafts. For inclines the case is different of course, and in use where the cable has to be carried on rollers or allowed to chafe against rock or timber, the round form has advantages. Where the hoist is a very deep one coned drums are sometimes used with round cables to equalize the work of the engines by giving them the most leverage where the load is heaviest and the greatest speed of cable (with the same speed of engine) where part of the weight of the cable is on the drum and not in the shaft. With the ribbon-reels used with flat cables this relation of leverage, speed and load is adjusted by the simple winding and unwinding of the reels. Besides these points, it seems tolerably evident that the thin flat cable ought to withstand the effect of bending on the reels and over the sheaves better than the round form, though this has been disputed. One thing is certain about all kinds of hoisting cables, and that is that neither reels nor sheaves are often made with a sufficient diameter to give the rope a fair show.

A REMARKABLE mode of occurrence of gold is that of the new Moondilla field in Queensland, as described by Dr. Robert L. Jack, the Government Geologist. He reports the groundwork as consisting of what is known as "cement," a somewhat consolidated mass of materials, mainly siliceous, but in part felspathic. This cement, on being broken and washed, is found to contain a considerable quantity of hydrous silica, which is not in rounded, waterworn grains, but in concretions or nodules; and sometimes the silica, when in large quantities, forms lenticular masses and even beds, strata or seams interstratified with the cement. The silica presents every variety of the chalcedony group, ranging in color from smoky to yellow, pearly, milk-white and water-clear, and also distinguishable from the auriferous stone of any other known gold fields by its low specific gravity. Dr. Jack ascribes the origin of the deposit to flows of warm water, during a period of volcanic activity, carrying silica in solution, and with it a little gold, depositing a hydrous silica in and among the material of the cement bed. He thinks there is no reason to suppose that the gold, any more than the silica, was carried from a distance, or came from any pre-existing vein. From this description it would appear that this is an instance of a gold-bearing surface bedded deposit formed in place, in which the gold, instead of being an original portion of the sedimentary strata, has been carried into them subsequently by infiltration.

ANOTHER mine is added to the list of those having a complete electric plant, the Queen of the Hills, Montana. The plant consists of four type D Thomson-Houston generators especially wound for 220 volts and two of which are provided with rotating brush devices for obtaining alternate current for drills, these generators also supplying direct current for pumps. The other generators will be used to supply power for two hoists, of 100 horse-power each, capable of working the mine to a depth of 1000 feet. The pump is of the Gould pattern, supplied with the Thomson-Houston motor. The latest design of percussion drills are to be put in use. In appearance they are similar to the ordinary compressed-air drills, having the same reciprocating motion, the wires being used in the one instead of the pipe in the other and being a flexible insulated cable is readily adjustable to any position in the mine.

THE journal *Stone*, the able exponent of the quarrying industry, says that "one is apt to grow despondent at the great number of new quarries being opened in all parts of the country," but takes some comfort in doubting if the increase in quarry output more than keeps pace with the growth of population. That is rather a pessimistic view to take of the matter. The opening of new quarries would seem rather to indicate a great increase in the demand, which is probably growing at a very much more rapid pace than population. Statistics of quarrying are very hard to obtain and likely to be unreliable, but one has only to use his eyes to be convinced of the increase. Moreover there is a greater tendency to transport stone long distances, as the popular taste calls for particular combinations, and this relieves the local markets.

THERE are perhaps half a dozen of the precious-metal mining companies whose directors adhere to a rigid policy of carrying a healthy cash reserve, instead of paying out in dividends and extra dividends all or nearly all the profits made from month to month. Where such is the financial policy the shares do not see-saw up and down spasmodically, and it is pretty safe to assume that the technical management of the mines is carried on with system and on far-sighted lines. A company that pays fitful dividends now and then, and then is in straits for months, can never operate its mine to good advantage. This, altogether apart from the question of manipulating stock prices by intermittent dividends and assessments—which of course is not mining.

FIVE countries produce 90 per cent. of the world's supply of pig iron—the United States, Great Britain, Germany, France and Belgium, in the order named; the United States leading with an output of 8,279,870 gross tons, out of the total of between 24,500,000 and 24,750,000 tons made in 1891. Whether iron or sulphuric acid (as some have suggested) is to be taken as an index of civilization is still a mooted question. At all events it is pretty certain that a very large proportion of the world's progress can be attributed to the countries which produce them most largely, and there seems to be decidedly something more than coincidence in it. A comparison of users would be fairer perhaps.

IN connection with the very complete diamond exhibit which is promised to be made by Cape Colony at the Chicago exposition, it is proposed to send one hundred tons of pulverized blue earth and fifty tons of unpulverized earth, together with a complete washing outfit, to be operated by natives. It is not stated whether the idea is merely to wash out such diamonds as may be already present in the material, or whether to make it interesting and more exciting, the exhibitors will dump in a few handfuls of uncut stones, so as to prove the accuracy of the concentrating process. In the latter case they would be doing what is sometimes done in vanner tests, where a weighed amount of gold dust is mixed with a few tons of barren sand and then recovered by the machine.

MINING in Newfoundland, according to a recent official report, is still confined to narrow limits along the coast, owing to the absence of roads through the interior. The mines being worked are for copper, antimony, iron pyrite and galena. The industry is yet in its infancy, but the country gives promise of great development in this direction. Zinc, manganese, chromium, nickel, iron, gold, etc., are known to exist in Newfoundland, while of the earthy minerals and non-metallic substances there is a great variety, including building stones, gypsum, asbestos, fluorspar, graphite, mica and pottery clays. Recent discoveries of coal (one bed of twenty-seven feet) have also been made.

THE Supreme Court of West Virginia has affirmed the constitutionality of the new State law forbidding mining-companies to issue scrip or checks in payment to their men, such checks to be exchanged for goods at the store of the employer. A good thing, too, for both sides. Mining and store-keeping should be kept apart.

MACHINE-SHOP NOTES.

Conducted by Albert D. Pentz.

THE rule that the top of the jaws of a vise should be placed just the height of the elbow is wrong. No filer with a practice that gets economical results can file with his body erect and his arm approximately pendant from the shoulder. On the contrary, he should place his right foot well aback to brace himself, face partly to the right, and keep his left foot forward under his weight. The file handle at the start should be about four inches below the shoulder, about six inches nearer the vise than the shoulder, and near the breast. The right thumb should lie straight forward on the file handle, the end of this handle should press back into the hollow of the palm and the fingers should grasp it from the under side. The palm at the joint of the left thumb should lie upon the point of the file and the tips of the first and second fingers should grasp it from beneath, while the thumb extends idly beyond. The elbows should be kept near the body and the file near its point be laid on the work. Then the whole body should be swung forward and a heavy pressure placed on the file before it is moved. Next, with the body as rigid as possible the file is forced forward by the arms alone, for the effective filer strikes out from the shoulder, and the whole attention is directed to keeping it from taking a rocking motion. When the whole length of the file has been in operation over the piece, the body is quickly taken back to the original position and then the file is recovered by a quick action of both arms. A fourteen-inch file is long enough for all day and all the week work. I have seen Germans however use a longer file and take a step forward in cutting with it, but am satisfied that less work is thus done at a greater expenditure of strength. The vise should be just high enough to place the file level on the work naturally. I like to file a piece about five inches higher than my elbow.

Prof. Tyndall has demonstrated that it is natural attraction, presumably akin to the capillary attraction, that holds two parallel surface plates together when they are rubbed in contact and that it is not atmospheric pressure, as was supposed. In my experience I have noticed that a hard steel plug gage will with no great pressure sometimes weld itself at one spot within a ring gage it tightly fits and so perfectly that it cannot be removed without destroying it as a gage. This often occurs with softer metals and there are facts which indicate that two pieces of the same metal unite together if they are perfectly clean, parallel and metallic when they are connected and subjected to pressure.

* * *

Being of an experimental bent of mind I recently made two boxes for a countershaft and lined the journals with paper board. The way I did it was thus;—but it is thought that this method can be improved on. The boxes were bored out three-eighths of an inch larger than the shaft and then the paper "trunk-board," three-sixteenths of an inch thick, was cut of a size to be the length of the boxes in one dimension and in the other dimension, when bent to a cylinder, to abut tightly end to end. These linings had been saturated in linseed oil and thoroughly dried. They were not very practical to ream, but at last satisfactory holes were made. In use, under a heavy belt pressure, these boxes seem to me to be excellent; and as far as I am able to judge in the few months they have been in use they have every good quality of Babbitt metals and are free from the viscous drag peculiar to these alloys.

* * *

Noah Kid started with nothing, and built up a jobbing business worth $20,000 a year. Then being modest and contented he gave the management of the shop and

a half ownership to his three sons. Now the sons are losing trade because they charge higher prices than their father did. These sons will be obliged to begin to live less expensively sometime and perhaps they should begin at once and save the business.

* * *

Nitro-chloric acid will recut files in about thirty seconds, but they will be good for nothing. After many experiments it is believed that a resuscitated file is of a very dubious economy. New files stand behind the reputations of their makers, and they will try to make them well. No one is responsible for a recut file.

* * *

Soft open-hearth machinery-steel "water-polishes" better than wrought iron. Do all machinists know that a sharp, stiff, square-nosed tool, if kept wet at the point with water in which is dissolved enough sal soda to prevent rust, will finish a shaft or stud rounder, smoother, brighter, cheaper and better than can be filed? If they do not, and they don't act as if they did, a trip to the shops in Massachusetts where cotton and woollen machinery is made will convince them very quickly.

* * *

When the new toolmaker was given his first job, he collected the forgings and other stock and laid them out on his bench which he had previously covered with heavy brown paper. He then took the drawing and spread that out on the bench, and then he got up on a stool and put his heels up on a rung. Then he put his elbows on the bench, his chin on his palms and looked at the layout for nearly two hours. The only signs of life that he made in all that time was to write a few remarks away over in one corner of the bench paper. If Mr. McCash hadn't been so surprised he would have discharged him before he had made a stroke. When, however, that toolmaker began to make that jig it seemed to grow both day and night, but no one saw the man exert himself very much. He stood over a lathe, planer, or at his vise so calm, clean and dignified that no one could venture to ask him a question; but when the tool was done it was just right in all things and it had cost less than even Mr. McCash thought it should.

Mr. McCash gave Jack Swifter a similar job the same time the new man started in and Jack would have got it done about four days sooner, but an accident occurred on the planer which necessitated the entire remaking of the body of the tool, so Jack was a week behind. Method is not all, but it helps.

* * *

If a shop has been running a long while a great many experiments may be demonstrated by judicious selections from the scrap-heaps.

* * *

The spirits of turpentine, as illustrated in the drilling of glass where it absorbs all the heat and thus prevents local expansion and consequently the cracking of the brittle fabric indicates that its affinity for heat is very great. This is more strikingly illustrated with a few pounds of old-fashioned gunpowder, which may be covered with spirits of turpentine, that liquid set afire and be entirely consumed and the flame will die out without heating the gunpowder to ignition. Perhaps this greed of turpentine for heat might be put to advantage in hardening steel. I would suggest the limited addition of it to the oil quenching bath, and the combining of it with cyanide potassium in a sort of emulsion or soapy liquid. It is so inflammable that it cannot be used pure. This application is entirely speculative.

* * *

There is a popular misapprehension as to the hardness of glass. It is softer than hard steel and much softer than corundum (emery), so don't tell any one to make a tool "glass-hard" for a file scratches a window and a hard flat drill will (with spirits of turpentine) drill glass after a fashion.

* * *

Of course a large or long sheet metal blank cannot be *plumped* through a die when both punch and die are flat and parallel-faced without straining everything and taking unnecessary power. If, however, the punch be "sheared" to cut the middle of the blank first and finish at the

corners or ends, the blank will be crooked and larger than the die; but if the die be sheared so as to be highest in the middle and lowest at the corners or ends, and the punch be left flat, the blank will be flat and of the proper size. Shear the die if possible, but if the punch must be sheared let it cut at the ends or corners first. The thickness of the blank is shear enough ordinarily but don't let it begin at a corners so as to form an acute angle, but let the punch or die be flat back from the corners or ends about two thicknesses of the blank at least.

* * *

Tom, the foreman, gave a piece of work to the boy Max to finish which was of a better class than he before had done. The boy spoiled it, but said that Dick Knight had wrongly instructed him about it. It was a job that Dick usually had done, and there were circumstances that pointed to the truth of Max's tale that he had wilfully caused the boy to do bad work. Dick was discharged, and four men who sympathized with him did not come to work the next day nor in fact for a whole week. Then, one after another, they returned to work, explaining that they had been sick. Incidents of this type happen every day, and to those whose ideas tend toward the advancement of the manual classes, they go far to reconcile them to things as they are.

* * *

B. Y. M., Brooklyn, N. Y., asks: "Will not this plan overcome the difficulty of soldering to cast iron? Brighten the surface that is to be soldered and then rub on it a piece of bluestone, which at once plates the iron with copper. This is a kind of electric-plating business? Then, as solder easily flows on copper and sticks to it, two pieces of cast iron should as certainly be well soldered to each other as two of copper?"

It is true that a bright surface on cast iron can be coated with copper in the way you state, but it is not technically an electrical effect. "Bluestone" is the sulphate of copper, *i. e.*, sulphuric acid saturated with metallic copper. Now iron is much preferred to copper by this acid, so much so that it will leave the copper entirely to combine with iron or zinc. Hence, when the bluestone is wet with water and rubbed on bright iron, the acid deserts the copper and combines with the iron, leaving the copper in a metallic state and in a thin coat on the bright surface of the iron. Under this coat of copper, then, there is a thin film of sulphate of iron made by the acid which has left the copper and attacked the iron, so that there is no great union between the two metals. If the rubbing of the bluestone be repeated a number of times the metallic copper color will disappear and the green "copperas" or sulphate of iron color will take its place. It is possible that the thin coat of metallic copper on cast iron may freely be soldered; but it is problematical whether there is anything to be gained by it as the weak joint then would be between the copper and the iron, or in the thin film of iron sulphate which has but little cohesive strength in itself and can have no firm adhesion to either of the metals it is in contact with.

* * *

K. R. J., Methuen, Mass., asks: "I have been trying to lacquer some electrical instruments, but after the varnish dries it peels off. The trouble is not in the varnish, as I buy that from a good dealer who sells it to others who use it without trouble. What is the matter? The dealer doesn't know." And we don't know for certain; but most probably the cause is that you applied it when the metal was cold. If you will warm the metal to about 210° F. or 100° C., and if the lacquer is made of shellac and alcohol, you will find it to adhere perfectly and it will dry at once.

* * *

Files that have ever been used on iron or steel will not cut brass or any of the other copper alloys at all to advantage.

* * *

Large ratchet teeth from a solid blank may be *sawed* out in two cuts with more economy in time than by one cut of one cutter. Besides, the resistance of a saw will not strain the web of the wheel like that required to oppose the stress from a wide milling cutter.

COMMENT & CRITICISM.

Some Suspected Errors.

JUDGING from the rapid reduction in the cost of railway transportation during the past few years, caused less by the increase of competition than by the enormous increase of the amount of merchandise transported and the consequently greater profits, it seems evident that the day is not distant when the mere cost of handling freight for the purposes of water carriage will preclude the possibility of any appreciable proportion of the commercial traffic of the country seeking this channel. The railways will finally become the cheaper as well as the more expeditious means of communication. I do not, therefore, place a very high estimate on the future value of water ways as a means of transcontinental transportation. Nevertheless, I have been deeply interested in the articles by Mr. T. Graham Gribble, entitled The Future World's Highway, published in the April and May numbers of THE ENGINEERING MAGAZINE. They are written in a scholarly style, and are interesting for their facts. I must be permitted, however, to make one or two objections. The first objection may sound a little like captious criticism; but it is always best to be accurate in statements of fact. In the course of his discussion, Mr. Gribble is led to make some statements about the Niagara river which will not quite bear the test of an examination. He says that it is estimated that the discharge over the two falls of Niagara, the American and the Canadian falls, is 400,000 cubic feet per second, and that the depth of water at the crest is twenty feet. Now, this is an estimate that ought not to have been made, and, if made, it ought not to have been repeated. It seems doubly inaccurate.

The Niagara river at Black Rock, now a portion of the city of Buffalo, two or three miles below Lake Erie, is about one mile wide, twenty-five feet deep in the channel, and it flows at the rate of six miles an hour. This will give a flow, approximately of nine feet per second. But of course the depth is not uniform. It is only twelve feet deep at the pier which extends from Black Rock up to the lake to form the head of the Erie canal, and it shoals necessarily towards the Canadian shore. But say that the average depth is fifteen feet, an estimate more likely to be under than over the true figure. On this estimate then, we find the flow of water to be 675,000 cubic feet per second. This is nearly double the estimate adopted by Mr. Gribble, and this water all goes to the falls as soon as it can get there. Now, as to the depth of water at the crest of the falls. It was never sounded by any human being, and never can be sounded; but we can estimate it approximately. Mr. Gribble's estimate says that it is twenty feet deep; but we must remember that the river at the falls is still nearly a mile wide, broken only by the thousand feet that Goat Island interposes along the crest of the waterfall. Considering the horse-shoe shape of the crest, however, it is probably that there is fully a mile of tumbling water. Yet the current of the same width, running at the rate of only six miles an hour at Black Rock, is only twenty-five feet deep at the deepest point. How, then, can it retain a depth of twenty feet at the crest when for a long distance before reaching the crest it has been dashing down a declivity of fifty-two feet fall to the mile at the rate of sixty miles an hour? Approximately, as six is to sixty so must be the depth at the crest compared with the depth at Black Rock. If the current retains a depth of four feet it must be because it is a good deal like sea-side lager beer. Twenty feet depth of water tumbling down the precipice of Niagara would bore a hole in the earth deep enough to extinguish Mount Etna.

Then let us get away from these riotous

and misleading waters and take a run with Mr. Gribble down to the mouth of the Mississippi. He pays a deserved tribute to Captain Eads; but here he makes a second complication which we could hardly look to see unraveled in a thousand years. He seems to maintain that the celebrated jetties have solved the problem of protection for the Mississippi valley. Perhaps so; but it was a little unfortunate that at the very time when his article went to press a new crevasse was deluging Louisiana a few miles north of the jetties, and that other crevasses have since been opened in the same neighborhood. If Mr. Gribble means that the jetties will protect the Mississippi valley when they have been constructed all the way to Cairo, he must be reminded that those already in service cost $8,000,000, and that though this country is pretty rich it is neither made of money nor willing to expend all the money it can get in protecting Mississippi valley plantations. It would be more economical to buy them all outright, and convert them into the bottom of an inland sea.

There must be some rose colored misconceptions here. It is commonly supposed that the jetties were constructed to keep open a navigable channel to New Orleans through the shifting sands at the mouth of the river. The people of New Orleans will be lucky if they continue rendering this service after the river, on one of its phenomenal tears some day, concludes to open a new chanel to the gulf and enlarge its delta.

TRUTH SEEKER.

New York, May, 1892.

Beauty in Works of Utility.

THE idea that engineering works of utility cannot be beautiful is so firmly fixed in the minds of many people that to eradicate it seems impossible. It is all wrong, and one of the prejudices that prevent true progress. Let us remember that beauty does not consist in applied and miscalled ornamentation, but in design and the perfection with which it fulfills its purpose. All admire a bridge with a graceful arch, and ingenuity has yet to invent something that will be more useful and answer the same purpose better than some bridges long in use. The many ugly bridges built only make the fact more evident. It is being more generally acknowledged that good and handsome work is the cheapest in the end. Some of our country towns spend enough in maintaining miserable plank bridges year after year to build graceful stone arches over all their streams, costing nothing to repair, if they would only make a beginning. A thing to be beautiful must answer the end in view. One of our crack yachts laid up on land is as ugly as a sunfish, and devoid of grace or poetry, yet in the water with sails spread and everything drawing it challenges comparison with the fish of the sea or birds of the air. Would any one hesitate for a moment to say our yachts are more beautiful than the Roman galleys, the Spanish galleons, or the old "seventy-fours," all once the pride of nations? Yet if the ancients had built water towers instead of aqueducts it does not seem possible that they could have erected such ugly structures as conspicuously crown so many of our hills.

From my window can now be seen two new and magnificent hotels. They are encrusted with marble and bronze through the lower stories, and above are enriched with artistic productions in terra-cotta or the sculptor's art. These in design are adapted from the antique and used as they were centuries ago. Did the buildings stop here they would be beautiful, but above and beyond them, more conspicuous than aught else, rise a hideous collection of chimneys, ventilators, and skylight roofs, ugly excrescences that people tolerate because they think they must. The Greeks had no use for such things and did not make them a part of their designs, but why does the modern architect do so? He knows they are wanted before he begins. They are seemingly beyond his skill. The sidewalk in front of one hotel is composed of gigantic slabs of stone, the pride of the quarry whence they came, smooth and without a flaw. They made a perfect walk when first laid, but in a few days stonecutters attacked them, and then were reared huge cast-iron supports for electric lights, large and strong enough to hold a

man-of-war or train of elephants, obstructing the way and keeping the light from below, which streams towards the zenith in a way to astonish the planets. The stones are further ruined by holes cut to communicate with the regions below, and covered with curving iron discs, upon which no pedestrian willingly treads.

It sometimes seems as if the art of design in its perfection was lost. Where do we behold a well-rounded scheme where the workers in stone, wood, iron and clay work to one harmonious end, neither destroying or conflicting with each other's work, and wasting their own? Yet in this same art of electric-lighting is shed rays of hope for the future; for at the other hotel light bronze supports, graceful enough to please a Corinthian, hold clusters of lights projecting from the building that illuminate an unobstructed walk below. People who have seen the first heavy and ungraceful chandeliers that were used for gas realize the advance that has been made. In railroad cars and station surroundings it is also apparent to all, and if in the end beauty and engineering are synonymous it will be because we have advanced as a whole people. We may never be able to construct such perfect pieces of mechanism as the human hand and arm, which has no waste or "ornamental" parts, and yet is the most useful and as beautiful a construction as we have knowledge of. It reaches its highest beauty when fully developed and with those most skillful in its use. When its usefulness is impaired by injury or want of use it lacks beauty to the same extent, and becoming useless may even be repulsive.

JOHN DE WOLF.

Direction of Impact of Explosives.

THE direction of greatest impact of dynamite, as noticed in the department of Civil Engineering in the February number of this magazine, is a question on which hardly any two persons agree. My experience with dynamite in the Michigan iron mines has been that it explodes with equal force in all directions, but does the greatest damage in the line of least resistance. The office floor in the Russell Sage case was simply too strong to yield to the force of the explosion. The nature of a dynamite explosion varies greatly with the purity and temperature of the explosive. When it is slightly frozen its effects are much like gunpowder. In the spring of 1890 an explosion of 200 pounds of dynamite took place in the bottom of a shaft at Negaunee, Mich. The shaft was 250 feet deep, and large timbers, rocks, ladders, etc., were thrown to the surface, while the rock bottom of the shaft was not injured in the least. I have often seen large rocks blasted by placing the dynamite against the side as well as on top of them.

W. H. HAMILTON.

Flint, Michigan.

A Correction.

IN the June number of your magazine, will you very kindly make a note of some typographical errors which occurred in my article on "Electric Street Railways as Investments" as printed in the May number? In the second paragraph on page 218, appears the following: "The census of 1890 shows that the street-railways of New York City carried during the year 2000 million passengers." This should have read "The street-railways in the United States carried during the year 2000 million passengers." In the same sentence the number of passengers carried on the steam-roads of the entire country is stated at 250 million, when it should have been 520 million. Again on page 221, paragraph number 3, the word "electricity" is used, where the word horses should have been printed. It should read: "Bonds on reorganized horse roads, whose net earnings with horses are sufficient to pay the interest on their bonded debt when equipped with electricity."

L. W. SERRELL.

New York, May 3, 1892.

THE TECHNICAL INDEX

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A An.... American Analyst. *f.* $1 per year. N. Y.
AA.....American Architect. *w.* $6 per year. Boston.
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A J Phar.American Journal of Pharmacy. *m.* $3 per year. Philadelphia.
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A H .....Annals of Hygiene. *m.* $2 per year. Phila.
A P B....Anthony's Photographic Bulletin. *s-m.* $3 per year. New York.
A R.....Architectural Record. *q.* $1 per year. New York.
A Rev....Architectural Review. *s-q.* $5 per year. Boston.
A & B....Architecture and Building. *w.* $6 per year. New York.
A .....Arena. *m.* $5 per year. Boston.
A & N J..Army and Navy Journal. *w.* $6 per year. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B & W...Builder and Woodworker. *m.* $1 per year. New York.
B P .....Bulletin of Pharmacy. *m.* $1 per year. Detroit.
C A.....California Architect. *m.* $3 per year. San Francisco.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
C & B... Carpentry and Building. *m.* $1 per year. New York.
C M.....Century Magazine. *m.* $4 per year. N. Y.
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C ..... .Compass. *m.* $2 per year. New York.
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D Jour...Druggists' Journal. *m.* $1 per year. Chicago.
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E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
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G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A.....Inland Architect. *m.* $3 per year. Chicago.
I R W...India Rubber World. *m.* $3 per year. N.Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
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J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
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M R.....Manufacturer's Record. *w.* $4 per year. Baltimore.
M N.....Mechanical News. *s-m.* $1.50 per year. New York.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.

Met W...Metal Worker. *w.* $2 per year. N. Y.
Min.....Minerals. *m.* $1 per year. N. Y.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R ...Mining and Scientific Review. *w.* $2 per year. Denver.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
Misc.....Miscellaneous.
N B .....National Builder. *m.* $3 per year. Chicago.
N C B...National Car Builder. *m.* $2 per year. N. Y.
N A R...North American Review. *m.* $5 per year. N. Y.
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P L .....Pacific Lumberman, Contractor, and Electrician. *w.* $3 per year. San Francisco.
P.....Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P Era... Pharmaceutical Era. *s-m.* $2 per year. Detroit.
P R.....Pharmaceutical Record. *s-m.* $1.50 per year. N. Y.
P T.....Photographic Times. *w.* $5 per year. N. Y.
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P S.....Power-Steam. *m.* $1 per year. N. Y.
P E. .....Practical Electricity. *f.* $2 per year. Boston.
P A .....Progressive Age. *w.* $3 per year. New York.
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N.Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R A.....Railway Age. *w.* $4 per year. Chicago.
R M M..Railway Master Mechanic. *m.* $1 per year. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R P.....Registered Pharmacist. *w.* $1 per year. Chicago.
R & T...Roofer and Tinner. *m.* $1 per year, N. Y.
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San.....Sanitarian. *m* $4 per year. Brooklyn.
S Era .. Sanitary Era. *m.* $1 per year. N. Y.
S P.....Sanitary Plumber. *s-m.* $1 per year. N. Y.
S M Q.. .School of Mines Quarterly. $2 per year. N. Y.
Sc.....Science. *w.* $3.50 per year. New York.
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S .....Stone. *m.* $2 per year. Indianapolis, Ind.
S R G ...Street Railway Gazette. *w.* $5 per year. Chicago.
S R N. ..Street Railway News. *w.* $3 per year. N. Y.
T Q.....Technology Quarterly. $2 per year. Boston.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
W E.....Western Electrician. *w.* $3 per year. Chicago.
W P M...Wilson's Photographic Magazine. *s-m.* $5 per year. N. Y.

The Foreign Press.

B J P....British Journal of Photography. *w.* 10*s.* 10*d.* per year, post-paid. London.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
C G.... ..Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R.....Contemporary Review. *m.* $4.50 per year, New York. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year. post-paid. London.
E P .....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L ....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
El.. .....Electrician. *w.* 24*s.* per year, post-paid. London.
El P.....Electricien. *w.* 25 *fr.* per year, post-paid. Paris.
E L.....Electricity. *w.* 6*s.* 6*d.* per year, post-paid. London.
Eng L... Engineer. *w.* 36*s.* per year, post-paid. London.
E.....Engineering. *w.* 36*s.* per year, post-paid. London.
F R.....Fortnightly Review. *m.* $4.50 per year. New York. London.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W.....Gas World. *w.* 13*s.* per year, post-paid. London.
G C.....Génie Civil. *w.* 45 *fr.* per year, post-paid. Paris.
I C B.....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid. London.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I L.....Industries. *w.* 32*s.* per year, post-paid. London.
Inv .....Invention. *w.* 28*s.* per year, post-paid. London.
I.... ....Iron. *w.* 30*s.* per year, post-paid. London.
J G L....Journal of Gas Lighting. London.
K.....Knowledge. *m.* 6*s.* per year, post-paid. London.
M .....Machinery. *m.* 9*s.* per year, post-paid. London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
M P.....Moniteur de la Photographie. *b-m.* 18 *fr.* per year, post-paid. Paris.
M I .....Moniteur Industriel. 3 times a week. 40 *fr.* per year, post-paid. Paris.
N C.....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 12*s.* 6*d.* per year. post-paid. London.
R N.....Railway News. London.
R U M...Revue Universelle des Mines. *m.* 40 *fr.* per year, post-paid. Paris.
S R.....Sanitary Record. *m.* London.
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3201. Public Indifference to Forests. Editorial (Misc.) 1050 w.

3205. Annealing Steel. A. D. Pentz (A M–April 7.) 1800 w.

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†3213. Theory and Practice. A. Ewbank (I E–March 5.) 1800 w.

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*3258. The Education of Engineers. Editorial (I L–April 1.) 1300 w.

*3259. English Law Relating to Telegraphs. I. (Ibid) 1250 w.

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3272. The Present and Future Coal Tar Market. C. H. Welch (Ibid.) 2200 w.

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NEW BOOKS OF THE MONTH.

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ANNUAIRE de 1892 de la Société des Ingénieurs. Paris: 10, Cité Rougemont. [8vo, paper, 280 p., 3 *fr.*]

Annuaire du Bâtiment (Sageret), des Travaux Publics et des Arts Industriels pour 1892. Paris: 15, Rue du Four-Saint-Germain. (8vo, 2183 p., 5 *fr.* 50.]

Auzillion.=Quinze Années d'observations d'orages dans le Département de l'Hérault. Montpellier: Boehm. [4to, paper, 4 p.]

Bolland, Simpson.=The Iron Founder. New York: Wiley. [12mo, cloth, 389 p., $2.50.]

Bottone, S. R.=A Guide to Electric Lighting for the Use of Householders and Amateurs. New York: Macmillan. [12mo, cloth, 189 p., 75c.]

Bournand, F.=Histoire des Arts Décoratifs et Industriels en France. Illustrated. Paris: Gédalge. [8vo, paper, 242 p., 5 *fr.*]

Buchetti, J.=Les Moteurs Hydrauliques Actuels. Traité théorique et pratique. I. Calculs et Conditions d'Établissement. Paris: J. Buchetti, 92, Boulevard Saint-Germain. [4to, paper, 188 p., 20 *fr.*]

Buguet, A.=Recettes Photographiques. Paris: 4, Rue Antoine-Dubois. [8vo, paper, 115 p.]

Burke, M. D.=Brick for Street Pavements. Cincinnati: Clarke. [8vo, paper, 50c.]

Coligny, R. de.=Du Soutien de la Cavalerie par des Fantassins dans les Temps Anciens et dans les Temps Modernes. [8vo, paper, 69 p.]

Cottens, Père.=Méthode Pratique pour Imprimer sur Zinc. Paris: Bernard & Cie. [16mo, paper, 64 p.]

Coupé, J.=Méthode Pratique pour l'Obtention des Diapositives au Gélatinochlorure d'Argent pour Projections et Stéréoscope. Paris: Gauthier-Villars et fils. [12mo, paper, 65 p., 1 *fr.* 25.]

Dépierre, J.=Traité de la Teinture et de l'Impression des Matieres Colorantes Artificielles. Deuxième partie: l'Alizarine artificielle et ses dérivés; généralités, historique, modes de préparation, propriétés, production, consommation, prix, mordants, huiles solubles, matériel, applications. Illustrated. Paris: Baudry & Cie. [8vo, paper, 613 p.]

Duhem, P.=Leçons sur l'Electricité et le Magnétisme. Paris: Gauthier-Villars et fils. [8vo, paper, 534 p., 15 *fr.*]

Dumas, A.=Le Tarif à Appliquer à Panama et les Revenus Probables du Canal. Paris: Bernard & Cie. [8vo, paper, 111 p.]

Dumas, A.=Projet d'Achèvement du Canal de Panama. Paris: Bernard & Cie. [8vo, paper, 116 p.]

Durand-Claye, A.=Hydraulique Agricole et Génie Rural. Paris: Doin. [8vo, paper, 705 p.]

Durer, E.=Edison, sa Vie, ses Œuvres. Paris: Marchesson. [18mo, paper, 113 p., 1 *fr.* 25.]

Ehrich, L. R.=The Question of Silver. New York: Putnam. [Cloth, 115 p., $1.]

Eichthal, E. d'.=Socialisme, Communisme, et Collectivisme. Coup d'œil sur l'histoire et les doctrines. Paris: Guillaumin & Cie. [18mo, paper, 215 p., 2 *fr.* 50.]

Engels, F.=The Condition of the Working-Class in England in 1844. With preface written in 1892. Translated by Florence Kelley Wischnewetsky. New York: Scribner. [Cloth, 319 p., $1.25.]

Etudes des Gîtes Minéraux de la France, publiées sous les auspices de M. le ministre des travaux publics, par le service des topographies souterraines. Bassin houiller et permien de Brive. Fascicule 1: Stratigraphie; par Georges Mouret. Paris: Imprimérie Nationale. [4to, paper, 463 p.]

Figuier, L.=L' Année Scientifique et Industrielle, ou Exposé Annuel des Travaux Scientifiques, des Inventions et des Principales Applications de la Science à l'Industrie et aux Arts qui ont attiré l'attention publique en France et à l'étranger, accompagné d'une nécrologie scientifique. Illustrated. Paris: Hachette & Cie. [16mo, paper, 635 p., 3 *fr.* 50.]

Flick, Taylor.=The Three Circuits. A study of the primary forces. Washington: Taylor Flick. [Cloth, 284 p., $1.50.]

Fourtier, H.=Dictionnaire Pratique de Chimie Photographique. Contenant une étude méthodique des divers corps usités en photographie, precédé de notions usuelles de chimie et suivi d'une description detaillée des manipulations photographiques. Paris: Gauthier-Villars et fils. [8vo, paper, 354 p., 8 *fr.*]

Fraenkel, J.=Les Canons à Tir Rapide de Gros Calibres. Paris: Berger-Levrault & Cie. [8vo, paper, 59 p.]

Francq, L.=Chemin de Fer Métropolitain. Recueil des articles publiés dans le journal le Métropolitain, à propos de la traction du Métropolitain Parisien. Paris: Bernard & Cie. [4to, paper, 97 p.]

Garnier, C., et Ammann, A.=L'Habitation Humaine. Illustrated. Paris: Hachette & Cie. [4to, paper, 895 p., 25 *fr.*]

Georgiades, D.=Le Développement Economique de la Grèce Contemporaine. Paris: Chaix. [8vo, paper, 15 p.]

Gregg, D. A.=Architectural Rendering in Pen and Ink. In four parts. Parts 1 and 2. Boston: Ticknor. [Paper, $2 each.]

Grimshaw, Robert.=Record of Scientific Progress for 1891. New York: Cassell. [8vo, cloth, 372 p., $1.50.]

Gripois, J.=Sur la Construction d'un Chemin de Fer Transsaharien et sur les Installations Destinées à le Protéger. Nancy, France: Berger-Levrault & Cie. [8vo, paper, 8 p., $1.50.]

Guilaine, L.=La République Argentine Physique et Economique. Exposé de ses conditions et ressources naturelles, de son agriculture, de ses industries, de son commerce, de son crédit, et de ses finances au point de vue de l'émigration et des capitaux Européens, d'après les derniers documents officiels. Préface d'Emile Gautier. Paris: Motteroz. [8vo, paper, 382 p., 7 *fr.* 50.]

Guyot, Arnold.=Social Economy. New York: Scribner. [12mo, cloth, $1.25.]

Herkomer, Hubert.=Etching and Mezzotint Engraving. Lectures delivered at Oxford. New York: Macmillan. [Cloth, 107 p., $16.]

Hospitalier, E.=Formulaire Pratique de l'Electricien. Paris: G. Masson. [18mo, paper, 360 p.]

Hurst, G. H.=Silk Dyeing, Printing and Finishing. London: Bell & S. [8vo, cloth, 232 p., 7*s.* 6*d.*]

Kohler, F. J.=Manuel Pratique du Conducteur de Travaux. Etudes et construction de chemins de fer et de routes. Paris: Bernard & Cie. [16mo, paper, 428 p.]

Le Van, W. B.=Safety Valves: Their History, Invention, Antecedents, and Calculations. New York: Henley. [Cloth, $1.50; leather, $2.]

Levett, R., and Davison, C.=Elements of Plane Trigonometry. New York: Macmillan. [12mo, cloth, 536 p., $1.60.]

Locard, A.=Minéraux Utiles et Pierres Précieuses: leurs applications aux arts et à l'industrie. Tours, France: Cattier. [8vo, paper, 232 p.]

Louis-Lucas, P.=Du Rôle et de l'Organisation du Pouvoir Législatif dans les Sociétés Modernes. Paris. [8vo, paper, 13 p.]

Mathet, L.=Etude Complète sur le Développement et les développateurs. Guide pratique de leur emploi avec les surfaces sensibles au gélatino-bromure d'argent. Illustrated. Paris: 24, Boulevard Saint-Germain. [16mo, paper, 71 p., 2 *fr.*]

Mathet, L.=Guide Pratique pour l'Emploi du Papier Albuminé. Illustrated. Paris: 24, Boulevard Saint-Germain. [16mo, paper, 87 p., 2 *fr.* 50.]

Mathet, L.=Le Nouveaux Procédés de Tirage. Collodio-chlorure; Gélatino-bromure; Platinotypie; Ferro-prussiate: Procédé au charbon; Tirages photocollographiques, etc. Illustrated. Paris: 24, Boulevard Saint-Germain. [16mo, paper, 131 p., 3 *fr.*]

Mayer, G.=Les Chemins de Fer: historique, construction, exploitation. Paris: F. Alcan. [32mo, paper, 186 p., 60 centimes.]

Miculescu, C.=Sur la Détermination de l'Equivalent Mécanique de la Calorie. Paris: Gauthier-Villars et fils. [4to, paper, 43 p.]

Monrocq, L.=Manuel Pratique de Lithographie sur Zinc. Paris: Bernard & Cie. [16mo. paper, 126 p.]

Orton, Edward.=Report on the Occurrence of Petroleum, Natural Gas, and Asphalt Rock in Western Kentucky, Based on Examinations Made in 1888 and 1889. Frankfort, Ky.: Geological Survey of Kentucky. [4to, cloth, 233 p.]

Ott, A.=Traité d'Economie Sociale, ou l'Economie Politique Coordonnée au Point de Vue du Progrès. 2 vols. Paris: Fischbacher. [8vo, paper, 1021 p.]

Pegot, J.=La Télégraphie Duplex Théorique et Pratique. Paris: Bernard & Cie. (16mo, paper, 134 p.]

Picou, R. V.=Les Moteurs Electriques à Champ Magnétique Tournant. Paris: Baudry & Cie. [8vo, paper, 33 p.]

Ponteaux, A.=La Poudre sans Fumée et les Poudres Anciennes. Dijon. France: Damidot. [8vo, paper, 181 p.]

Robinson, J.=Our Trees: popular account of the trees in the streets and gardens of Salem, and of the native trees of Essex Co., Mass. Salem: Essex Institute. [8vo, paper, 120 p., 75c.]

Rock Drills as Applied to Mines, Tunnels and Quarries. New York: Ingersoll-Sergeant Drill Co. [4to, paper, 223 p., free.]

Schraubstadter, C., Jr.=Copy for Photo-engraving. St. Louis: C. Schraubstadter, Jr. [Paper, 22 p., 25 cents.]

Schuyler, Montgomery.=American Architecture: Studies. New York: Harper. [Leather, 218 p., $2.50.]

Shepp, J. W. and D. B.=Shepp's Photographs of the World: consisting of photographic views of cities, street scenes public buildings, etc.; with instantaneous photographs showing the everyday life of the people in the various countries of the world. Also direct copies of famous paintings and statuary by the world's old and modern masters, taken from the leading galleries; carefully arranged and appropriately explained. New York: Hegger. [Cloth, $5; half russia, $7.50: *édition de luxe*, russia, $16.]

Snell, S.=Miners' Nystagmus and Its Relation to Position at Work and the Manner of Illumination. Bristol, Eng.: Simpkin. [8vo, 140 p., 6*s.*]

Statistique de l'Industrie Minérale et des Appareils à Vapeur en France et en Algérie pour l'Année 1889; avec un appendice concernant la statistique minérale internationale et une notice sur le nombre, les salaires, et la durée du travail des ouvriers des mines en 1890. Illustrated. Paris: Veuve Dunod. [4to, paper, 273 p., 10 *fr.*]

Transactions of the American Institute of Electrical Engineers. Vol. VIII. New York; Published by the Institute. [8vo, cloth, 635 p.]

Tumlirz, O.=Théorie Electromagnétique de la Lumière. Ouvrage traduit de l'Allemand par G. Van der Mensbrugghe. Paris: Hermann. [8vo, paper, 173 p.]

Vigreux, L.=Application de l'Eau sous Pression. Projet de manutention hydraulique dans une gare de chemin de fer. Paris: Bernard & Cie. [8vo, paper, 148 p., 20 *fr.*]

Voirin, J.=La Photographie et Ses Applica-

tions. Manuel pratique de phototypie. Paris: Mendel. [16mo, paper, 88 p.]

Weimer, Albert B.—The Law Relating to the Mining of Coal: being a collection of the constitutional provisions, statutes, and decisions relating to coal-mining in Pennsylvania. Philadelphia: Bisel. [Sheep, 226 p., $2.]

Whitely, R. Floyd.—Chemical Calculations; with explanatory notes, problems and answers, specially adapted for use in colleges and scientific schools. Preface by T. Clowes. New York: Longmans, Green & Co. [12mo, cloth, 114 p., 60c.]

Witz, A.—Traité Théorique et Pratique des Moteurs à Gaz. Paris: Bernard & Cie. [8vo, paper, 436 p., 15 *fr.*]

Worthington, A. M.—Dynamics of Rotation: An Elementary Introduction to Rigid Dynamics. New York: Longmans, Green & Co. [12mo, cloth, 168 p., $1.]

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